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17. Pedro Dairy-Antonio Pedro September 9, 2001

18. Jacob de Jong, River Ranch Dairy September 10, 2001


20. Western United Dairymen-Michael Marsh, CEO September 10, 2001

   5. Bruce C. Douglas, Global Sea Level Acceleration, 97 JOURNAL OF GEOPHYSICAL RESEARCH 12699-12706.
   7. C. Kuo, C. Lindberg & D.J. Thompson, 343 NATURE 709-713.
   8. A.N. STRAHLER ET. AL., ENVIRONMENTAL GEOSCIENCE (1973) at 30
   9. R. Essenhigh, Letter to Editor, WALL STREET JOURNAL, October 10, 2000
   11. R. Zhang, “Biology and Engineering of Animal Wastewater Lagoons,” undated, p. 4-6
   16. Employment Development Department (“EDD”), Labor Market Information
   17. Proof of Service, dated September 10, 2001

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22. Sierra Club-Aaron Isherwood, Counsel  
September 7, 2001  


2. Center on Race, Poverty and the Env’t v. County of Kern (Cal. Super. Ct. May 3, 2001) No. 242336, slip op. (ordering Kern County to perform a cumulative impact analysis considering both existing and planned dairies; revamp the alternatives section; analyze the health impacts of dairy operations; analyze the use of an aerobic treatment system; analyze solutions in the event of groundwater contamination; detail the volume of leakage anticipated from lagoons) (18 pages).  


5. Curriculum vitae of Alan E. Gay, P.E. (6 pages)  


15. Save Our Forest and Ranchlands v. County of San Diego, (Cal. Super. Ct. Aug. 31, 2000) No. 676630, slip op. (ordering County to prepare a revised EIR which analyzes the biological, botanical and hydrological resources at risk or impacted on certain lands) (9 pages).  

16. Center on Race, Poverty and the Env’t v. County of Kern (Cal. Super. Ct. May 3, 2001) No. 242336, slip op. (ordering Kern County to perform a cumulative impact analysis considering both existing and planned dairies; revamp the alternatives section; analyze the health impacts of dairy operations; analyze the use of an aerobic treatment system; analyze solutions in the event of groundwater contamination; detail the volume of leakage anticipated from lagoons) (18 pages).  

23. **Kings Co. Farm Bureau-Chuck Draxler**  
*September 10, 2001*

1. Review of the Revised Draft Dairy Element of the Kings County General Plan, Section III – Policies for the Location and Siting of Dairies; Section IV – Design Criteria for Individual Dairy Projects; Dairy System Design Policy; Section V – Dairy Monitoring Program; Section VI – Dairy Conformance Program; Appendix B


4. Ordinance No. 587 – County of Kings Establishing Water Well Standards in Accordance with California Water Code Section 13801


9. California Regional Water Quality Control Board, Central Valley Region, *Fact Sheets For Dairies*


11. Combined SWRCB/CIWMB Regulations, Division 2, Title 27


14. CEQA GUIDELINES, “Chapter 2.5. Definitions”

15. CEQA GUIDELINES, “Chapter 2.6. General”

16. CEQA GUIDELINES, “Chapter 4.5. Streamlined Environmental Review”


22. CEQA GUIDELINES, “Final Adopted Revision to State CEQA Guideline 14 C.C.R. Section 15064(i) including nonsubstantial changes”

24. **Center for Race, Poverty and the Environment-Caroline Farrell**  
*September 10, 2001*

Appendix A

1. Letter from James Rader, Kings County Planning Agency Code Compliance Specialist, to Mr. and Mrs. Manuel Galhandro regarding Notice of Violation (March 23, 1998).

3. Letter from California Regional Water Quality Control Board, Central Valley Region to Mr. Manuel Galhandro regarding Notice of Violation (March 27, 2000) 1294-1295
4. Inspection Report from Central Valley Regional Water Quality Control Board regarding Discharges at the Galhandro Dairy (February 24, 2000). 1296-1301
5. Letter from James Rader, Kings County Planning Agency Code Compliance Specialist, to Manuel Galhandro regarding Notice of Violation and Order to Comply (April 10, 2000). 1302-1303
6. Estimated Timeline for Conditional Use Permit No. 98-14 (Galhandro) (Faxed December 4, year unknown). 1304

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8. Borba Farms Environmental Impact Report (September 3, 1999), at p. 4.3-9. 1437-1438

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10. Merced County Comprehensive Nutrient Management Plan at Table 6 (“Plant Food Utilization by Various Crops”). 1444

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   **September 14, 2001**  
   1661
William Zumwalt, Planning Director  
KINGS COUNTY PLANNING AGENCY  
Kings County Government Center  
1400 West Lacey Boulevard  
Hanford, CA 93230

Re:  Comments To Draft Dairy Element of Kings County General Plan  
And To Program Environmental Impact Report (December 2000 Version)

Dear Mr. Zumwalt:

I realize that you have withdrawn the above-referenced document with the intent of re-releasing it in the near future for public comment. But as you consider modifications to your draft, I would like to take this opportunity to submit some comments. While our firm represents a number of clients, some who are current dairymen, and some who may want to apply for Conditional Use Permits for dairies in the future, the following comments are not made on behalf of any specific client, but are the views of our firm with the benefit of the County's dairy industry in mind. These comments also reflect my views as a long-term resident of the County and as a former dairymen.

I am appreciative of the objectives of the County's dairy planning program. The preservation of our water resources and of the quality of the Valley's air are important. However, the document and program as now drafted incorporate provisions which will make it financially infeasible to locate new dairies in Kings County and to bring existing dairies into conformity. The resulting loss of jobs in, and income from, the County's dairies and allied industries will be significant.

My concerns include:

1. Despite admission in the document text that 'emerging ... technologies' such as anaerobic digestion or aerobic treatment of manure and manure water remain economically unproven for dairy usage, proposed Goal DE 5 requires their usage. The implementing policies offer amelioratory language, "... to the extent economically feasible," for example, in Policy DE 5.1.c. The determination of economic feasibility of treatment of the manure is not reserved to the dairymen.
but to the Kings County Planning Agency!

The implementation of this goal, by itself, will make continued dairy development in Kings County unlikely. Experimental or small-scale usage of anaerobic or aerobic treatment systems elsewhere without long-term, non-promoter and independent scientific evaluation of costs and results is not a reasonable basis for imposition of this requirement. The University of California, Davis, is proposing an experimental manure treatment facility at its expanded Tulare dairy facility. That venue is the proper one for such installations, not all of Kings County.

2. Goal DE 8 describes a "voluntary" program which would bring the existing dairies "into compliance by the end of 2006." Policy DE 8.1.c, implementing the "voluntary" program notes that "out-of-conformance dairies may be required to reduce herd size, or modify or cease their operations." The implications of this policy are clear. If enforced, the dairy industry in Kings County will not only not grow, but existing dairies, if unable to economically compete will go out of business.

3. Policy DE 6.1f provides that when standard testing methods for air emissions become available, the dairy owner/operator shall "test for these gases and emissions. Such a vague "policy" should not be included in the Dairy Element. There are no criteria for what constitutes their availability; the frequency, purpose, and cost of which cannot now be defined or estimated. It would be more appropriate to consider such a Policy as an amendment to the Element when "availability" is defined and confirmed.

4. Policy DE1.2c prohibits the establishment of new dairy facilities in designated flood hazard areas. While reasonable on its face, the policy unnecessarily limits dairy facility location. It is customary in other jurisdictions, and for other kinds of facilities in Kings County, to permit pads or berms to be installed to protect such facilities from 100-year flood events. To prohibit such a procedure for Kings County dairies is without merit.
5. It appears, based on the discussion on Cropland Water Use on Page 4.3-24 of the EIR, that Kings County proposes to limit cropping on land used for dairy manure application or manure water irrigations to the cropping (single or double) currently in use. If this is not the case, the Dairy Element should clearly state that dairy farmers may double crop their land as required, maintaining nitrogen and salt loading within Regional Water Quality Control Board limits, and that comprehensive nutrient management plans may reflect this ability. If this is the case, the policy proposed above again places Kings County dairies at a significant economic disadvantage by increasing the capital investment required for dairy establishments.

6. Policy DE 4.2b. This Policy states that "lagoons for treating and storing dairy process water and manure may be used provided that approved control of air emissions using best available control measures (BACM) is implemented." From a financial feasibility standpoint, this Policy should instead specify "best practical control measures (BPCM)," not "best available control measures (BACM)." The policy, as stated, effectively prohibits lagoon usage. It must be assumed that that is its intent.

7. Policy DE 5.1j. This policy essentially limits dairy size based on air emission issues. I do not believe your draft adequately examines or discusses the entire issue of aerobic versus anaerobic manure decomposition, the emissions produced under each method, and what portion of a dairy's manure decomposition proceeds under each method.

8. The Dairy Element's estimate of maximum total dairy herd capacity in Kings County, and the tables in Appendix A supporting that estimate, appear to be based on two limiting assumptions:

   (A) No land additional to that currently being double-cropped will be double-cropped for dairy farming.

   (B) No manure will be shipped out of Kings County.

It is customary in the San Joaquin Valley, under Regional Water
Quality Control Board regulations, to calculate allowable herd size on available land assuming double-cropping of dairy-support forage crops, and exporting solid manure off-site as required to reduce nitrogen loading to the point that salt loading is (at 3000 pounds per acre annually) the limiting herd size parameter. It is assumed, but should be stated in Kings County's Dairy Element, that this herd-size calculation procedure will be allowed. Of lesser importance to dairy applicants, but still worthy of note, is the fact that, absent these two illogical limiting assumptions, Kings County can accommodate a larger total dairy herd size that has been estimated in the Element.

9. My most intense objections arise from Section V (Dairy Monitoring Program) of your draft Dairy Element-Page DE-38+. My objections are most specifically directed at Policy DE 6.1f and DE 6.1g, which intend to impose on all dairymen the duty of maintaining daily logs regarding their manure handling events, individual sick cow treatments, ration formulations and feeding schedules, and cattle selection (which I take to mean that a dairymen must have to keep a log regarding what bull or bulls he uses to breed a given female).

In the first place, this proposal is wastefully duplicative. For example, protection of the groundwater is the responsibility of the Regional Water Quality Control Board. The United States Department of Agriculture and the Food and Drug Administration are responsible for the regulation of the use of medications and drugs on dairies. The local Mosquito Abatement District and the County's Health Department and Environmental Health Departments have their own responsibilities in monitoring certain aspects on County dairies. Your proposal simply adds an unnecessary, costly, and burdensome additional layer of regulatory encumbrances upon a dairy operator. Such efforts can result in confusion over requirements and restrictions which may be in conflict. It would impose burdens on the dairymen that goes beyond the legitimate exercise of the police power of this County. Imposing such requirements could be discriminatory, where it does not impose similar requirements on other farming enterprises. Like most other industries, the dairy industry is extremely competitive and a dairymen's ability to survive depends upon his ability to efficiently allocate his resources, and his ability to innovate with new and better procedures and techniques. Some such innovations may be proprietary, and requiring a dairymen to disclose them may raise
serious legal issues. I do not think it is any of the County's business to monitor how a dairymen selects his cattle, the bulls to which he mates, or how he feeds his herd.

Keep in mind that cows are not miraculous creatures. They do not create something from nothing. They do not produce milk out of only air and water. They must be fed, and fed as much as they will eat. Dairy nutritionists universally agree that the more a cow consumes, the more milk she usually produces. Dairies struggle to survive in an intensely competitive industry, and they must not be unduly encumbered in their management programs, especially in their feeding programs. To eventually get to a point where a dairymen is told by a governmental agency how to feed his cows is insanity. It is like requiring a soldier to throw down his rifle so that he may sooner arrive at the battlefield. A community will not benefit from jobs created by a business if the business cannot survive due to excessive and unwarranted governmental intervention and interference.

Detailed regulation of the dairy industry to the degree specified in your draft should raise alarm in the minds of anyone connected to farming, in that this draft could presage plans for further regulations in other aspects of farming in this County. It is respectfully requested that your proposed regulatory measures be substantially tempered, restrained, and modified to the maximum extent possible to permit continuation of a competitive dairy industry in Kings County.

Very truly yours,

GRISWOLD, LaSALLE, COBB,
DOWD & GIN, L.L.P.

By:

MICHAEL E. LaSALLE

MEL:mjd
cc: Tony Barba, Supervisor, District 4
     Joe Neves, Supervisor, District 1
     Tony Oliveira, Supervisor, District 3
     Jon Rachford, Supervisor, District 2
     Alene Taylor, Supervisor, District 5

c:wp31\mef\zumwalt.307

000005
April 10, 2001

Bill Zumwalt, Director of Planning
County of Kings
1400 W. Lacey Boulevard
Hanford, California 93230

Dear Mr. Zumwalt:

The Kings County Fire Department is proposing the following minimum standards for dairies in the County of Kings:

1. 20,000 gallons of water to be stored in a tank on site for fire suppression. The storage tank shall be equipped with a pressure system and a float device to keep the tank full at all times. The tank shall also have a 3-inch discharge line with a 2-1/2 inch National Standard Hose Thread male fitting for fire department connection. The male fitting shall have a cap to prevent accumulation of trash and debris within the fitting. The discharge line shall have a valve capable of controlling the flow of water.

2. Access roads 15 feet in width shall be provided to all structures, water storage and hay storage areas. The roads shall be of an all-weather surface capable of supporting heavy fire apparatus.

3. Hay storage shall not exceed 20 feet in height. Individual stacks of hay shall be limited to 400 tons and shall have a minimum 20-foot separation between aisles and rows of adjoining haystacks.

4. Hay storage shall not be allowed within 100 feet of a structure.

5. Storage of hay within a structure shall be limited to 100 tons. This does not include pole barns.

6. Agricultural shops that have repair facilities may be required to have automatic fire suppression systems installed depending upon operations and size of the structure. Fire hydrants may be required around structures depending upon operations and size.
7. The fire department reserves the right to address requirements on a case by case basis depending upon the hazard and size of the risk involved. The aforementioned standards are only a minimum and more stringent requirements may be applied.

I hope that this will assist you in preparing the dairy standards for the County of Kings, if you have any further need for assistance please feel free to contact me at (559) 582-3211 ext.2884. Thank you for allowing the Kings County Fire Department to address our concerns and needs regarding the dairy standards.

Sincerely,

Michael Virden, Fire Marshal
Notice of Preparation

April 16, 2001

To: Reviewing Agencies
Re: Revised Diary Element of the Kings County General Plan
   SCH# 2000111133

Attached for your review and comment is the Notice of Preparation (NOP) for the Revised Diary Element of the Kings County General Plan draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

   Bill Zumwalt
   Kings County Planning Agency
   Government Center
   1400 West Lacey Boulevard
   Hanford, CA 93230

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

   [Signature]

Brian Grattidge
Project Analyst, State Clearinghouse

Attachments
cc: Lead Agency
SCH# 200011133
Project Title Revised Dairy Element of the Kings County General Plan
Lead Agency Kings County

Type NOP Notice of Preparation
Description The proposed project, the Draft Revised Dairy Element of the Kings County General Plan (developed by the Kings County Planning Agency), presents a comprehensive set of goals, objectives, and policies to guide development, expansion, and operation of milk cow (bovine) dairies within the County. The Draft Revised Dairy Element and associated zoning ordinance amendments, hereafter collectively referred to as "the Element," is designed to accomplished two equally important major purposes. The first purpose is to ensure that the dairy industry of Kings County continues to grow and contribute to the economic health and safety and the environment. The County has determined that the best way to accomplish these combined goals is to adopt a separate general plan element that establishes development and operational policies for the local dairy industry.

Lead Agency Contact
Name Bill Zumwalt
Agency Kings County Planning Agency
Phone (559) 582-3211 x 2686
Fax 559/584-8989
email bizumwalt@co.kings.ca.us
Address Government Center
1400 West Lacey Boulevard
City Hanford
State CA Zip 93230

Project Location
County Kings
City
Region
Cross Streets
Parcel No.
Township
Range
Section
Base

Proximity to:
Highways 41, 43, 198
Airports Hanford Mun; Lemoore Naval AS
Railways
Waterways Kings and Tule Rivers, Cross Creek
Schools Station
Land Use Agriculture

Project Issues Agricultural Land; Archaeologic-Historic; Traffic/Circulation; Other Issues; Air Quality; Aesthetic/Visual; Flood Plain/Flooding; Geologic/Seismic; Drainage/Adsorption; Noise; Minerals; Public Services; Schools/Universities; Job Generation; Housing; Soil Erosion/Compaction/Grading; Cumulative Effects; Landuse; Growth Inducing; Wildlife; Wetland/Riparian; Water Supply; Vegetation; Toxic/Hazardous; Solid Waste; Septic System

Reviewing Agencies Resources Agency; Department of Conservation; Department of Parks and Recreation; Department of Water Resources; Department of Health Services; Department of Food and Agriculture; Department of Fish and Game, Region 4; Native American Heritage Commission; State Clearinghouse; Caltrans, District 6; Integrated Waste Management Board; State Water Resources Control Board, Division of Water Quality; Regional Water Quality Control Bd., Region 5 (Fresno); Other Agency(ies)

Date Received 04/16/2001 Start of Review 04/16/2001 End of Review 05/15/2001

Note: Blanks in data fields result from insufficient information provided by lead agency.

000009
**NOP Distribution List**

**Resources Agency**
- Resources Agency
  - Nadell Gayou
- Dept. of Boating & Waterways
  - Bill Curry
- California Coastal Commission
  - Elizabeth A. Fuchs
- Dept. of Conservation
  - Ken Troll
- Dept. of Forestry & Fire Protection
  - Allen Robertson
- Office of Historic Preservation
  - Hana Kastberg
- Dept of Parks & Recreation Resource Mgmt. Division

**Fish and Game**
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  - Scott Flitt
  - Environmental Services Division
- Dept. of Fish & Game
  - Donald Koch
  - Region 1
- Dept. of Fish & Game
  - Banksy Curtis
  - Region 2
- Dept. of Fish & Game
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  - Region 3
- Dept. of Fish & Game
  - William Lautenzik
  - Region 4
- Dept. of Fish & Game
  - Sandy Peterson
  - Region 5, Habitat Conservation Program
- Dept. of Fish & Game
  - Gabriela Gisela
  - Region 6, Habitat Conservation Program
- Dept. of Fish & Game
  - Tammy Allen
  - Region 6, Inyo/Mono, Habitat Conservation Program
- Dept. of Fish & Game
  - Tom Naples
  - Marine Region

**Independent Commissions**
- California Energy Commission
  - Environmental Office
- Native American Heritage Comm.
  - Debbie Treadway
- Public Utilities Commission
  - Andrew Barnsdale
- State Lands Commission
  - Sandy Silva
- Governor’s Office of Planning & Research
  - State Clearinghouse Planner
- Dept. of Transportation
  - Mercin Bergamask
  - District 6
- Dept. of Transportation
  - Stephen J. Buswell
  - District 7
- Dept. of Transportation
  - Mike Sim
  - District 8
- Dept of Transportation
  - Caroline Yee for Kate Walton
  - District 9

**County:** Kings

- Dept. of Transportation
  - Chris Sayre
  - District 10
- Tahoe Regional Planning Agency (TRPA)
  - Lynn Barnett
- Office of Emergency Services
  - John Rowden, Manager
- Delta Protection Commission
  - Bobby Eddy
- Santa Monica Mountains Conservancy
  - Paul Echalain

**Dept. of Transportation**
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- Dept. of Transportation
  - Vicki Roe
  - Local Development Review, District 2
- Dept of Transportation
  - Jeff Pulverman
  - District 3
- Dept of Transportation
  - Jean Finney
  - District 4
- Dept of Transportation
  - Lawrence Newbark
  - District 5
- Dept of Transportation
  - S. O. L. O. A.
  - District 6
- Dept of Transportation
  - Diane Edwards
  - Division of Clean Water Programs

**Business, Tens & Housing**
- Housing & Community Development
  - Cathy Truswell
  - Housing Policy Division
- Caltrans - Division of Aeronautics
  - Sandy Hessard
- California Highway Patrol
  - Lt. Dennis Brunette
  - Office of Special Projects
- Dept of Transportation
  - Ron Holsen
  - Caltrans - Planning
- Dept of General Welfare
  - Robert Steffy
  - Environmental Services Section

**Air Resources Board**
- Airport Projects
  - Jim Lerner
- Transportation Projects
  - Ann Garaghlin
- Industrial Projects
  - Mike Tolands

**Regulatory Water Quality Control Board (RWQCB)**
- RWQCB
  - Carissa Hudson
  - North Coast Region (1)
- RWQCB
  - Environmental Document Coordinator
  - San Francisco Bay Region (2)
- RWQCB
  - Central Coast Region (3)
- RWQCB
  - Jonathan Bishop
  - Los Angeles Region (4)
- RWQCB
  - Central Valley Region (5)
- RWQCB
  - Central Valley Region (6)
  - Fresno Branch Office
- RWQCB
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  - Lahontan Region (6)
  - Victorville Branch Office
- RWQCB
  - Colorado River Basin Region (7)
- RWQCB
  - Santa Ana Region (8)
- RWQCB
  - San Diego Region (9)

**Oakland**
April 23, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230

SUBJECT: Notice of Preparation of a Program Environmental Impact Report – Draft Dairy Element of the Kings County General Plan

Thank you for the opportunity to give our views on the scope and content of the environmental information which should be included in the Program Environmental Impact Report (PEIR). We offer the following suggestions:

The PEIR should thoroughly evaluate the protection of groundwater quality in the context of future dairy development. The disposal of manure and wastewater generated by dairies has resulted in the pollution of groundwater by both nitrates and salts. This problem has been by no means limited to Kings County and has been amply demonstrated in the Chino Basin and in the Visalia area. U.S. Geological Survey Circular 1159 states that “data from wells in the eastern San Joaquin Valley that were less than or equal to 200 feet deep indicate that median nitrate concentrations increased significantly from the 1950s to the 1960s, and from the 1970s to the 1980s.” The increase in the number of dairies and other confined-animal feedlots is cited in that document as a contributing factor along with an increase in the application of nitrogen fertilizer. It goes on to point out that nitrate concentrations in excess of 2.0 mg/L indicate degradation from overlying land use.

The presence of nitrates in groundwater is a hazard to public health. The use of nitrate-contaminated drinking water to prepare infant formula can result in a condition known as infant methemoglobinemia or “blue baby syndrome.” Affected infants develop a peculiar blue-gray skin color and may become irritable or lethargic, depending on the severity of their condition. The condition can progress rapidly to cause coma and death if it is not recognized and treated appropriately. A recent article in the journal, Environmental Health Perspectives 108:675-678 (2000), reports on the investigation of two cases of methemoglobinemia in Wisconsin. Both cases involved infants who became ill after being fed formula that was
reconstituted with water from private wells. Water samples collected from these wells during the infants' illnesses contained nitrate-nitrogen concentrations of 22.9 and 27.4 mg/L.

Parts of Kings County are poorly drained and are characterized by perched water tables. In particular, this is true of the Island District and elsewhere in the northwest portion of the county where large numbers of dairies are now located. However, areas with high water tables are not conducive to the operation of dairy farms, wastewater lagoons or the land application of large volumes of manure due to the impact of salts and nitrates on groundwater quality. Abandoned and poorly constructed water wells serve as conduits for the movement of pollutants from shallow perched groundwater to the deeper aquifers we rely upon for domestic, agricultural, and industrial use. Therefore, we strongly recommend that the Dairy Element designate high water table areas as "sensitive areas" where dairies would be prohibited.

The PEIR should consider the potential environmental advantages of non-traditional means of managing dairy wastes such as the on-site or off-site composting of manure, anaerobic digesters, and Autogenous Thermophilic Aerobic Digestion (ATAD). The Draft Manure Management Strategy Report for the Chino Basin, Santa Ana River Watershed, September 1999, presented by the Santa Ana River Watershed Group (SARWG) states that the application of ATAD to processing waste streams has been intensively studied for over 40 years. The SARWG report claims that ATAD allows a facility to rapidly transform organic matter into useful fertilizer or feed products while achieving a high degree of disinfection using a small footprint and with little or no impact on the local environment. Reportedly, in the Chino Basin Dairy Area (CBDA), a private development group is analyzing the feasibility of installing a regional manure ATAD system.

The PEIR should also consider the possible environmental impacts of the land application of dairy manure that may be imported from outside the county. The pressures of urbanization and the environmental problems resulting from years of dairy waste disposal within the Chino Basin have forced the dairy industry there to export its waste. For example, the SARWG report referenced above states in Section 4.3.6:

A second pilot project is under consideration for direct land application of manure to up to 50,000 acres of farmland in Kings County. A large farming operation has available up to 50,000 acres of land suitable for manure land application. The farmer proposes a year-round project
operating 300 days per year at the rate of 1,000 tons of manure per day. To launch this project the farmer is requesting a three-year project commitment at the rate of $16.00 per ton of manure. The distance between the CBDA and the property in Kings County is approximately 220 miles each way.

The entire SARWG report may be downloaded at http://www.sarwg.org/TOC2/MMSToc.htm

The last paragraph of the Notice of Preparation lists the major issues to be analyzed in the PEIR. We concur that they are all worthy of consideration. However, it is suggested that the most thorough analysis be made of impacts to water resources and water quality, air emissions and odors, and of course, public health.

The careful preparation and rigorous enforcement of a Dairy Element can be a major step towards providing for the orderly expansion of the dairy industry in Kings County while simultaneously protecting the quality of life and environmental health in our county. We look forward to working with you and your Agency on this important and long-awaited project.

Sincerely,

[Signature]

Keith Winkler, REHS
Director of Environmental Health Services

cc: Loretta Tucker, REHS
May 3, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Government Center
1400 W. Lacey Blvd.
Hanford, CA 93230

Subject: Notice of Preparation for an Environmental Impact Report for the Revised Dairy Element of the Kings County General Plan.

Dear Mr. Zumwalt:

The San Joaquin Valley Air Pollution Control District (District) has reviewed the Notice of Preparation (NOP) referenced above and offers the following comments:

We recognize that since the April 27, 2001 comment deadline has passed, the District's comments may not be considered. The recent proposals for large dairies in Kings County and in other Valley counties highlighted the need to identify the air quality impacts of continued expansion of the dairy industry. The District supports the inclusion of air quality as one of the major issues to be analyzed in the Program Environmental Impact Report (PEIR).

There have been several EIRs prepared recently for Valley dairy projects and county confined animal ordinances and management plans. These documents contain excellent discussion and analysis of emission factors used to determine the level of impact from dairy operations and on the effectiveness of control measures and management practices designed to reduce odor and emissions of criteria pollutants. The District can provide references for these documents if needed.

The air quality section of the PEIR should use information provided in the District's Guide for Assessing and Mitigating Air Quality Impacts (GAMAQI). The GAMAQI provides a complete description of the regulatory environment and existing conditions for air quality in the San Joaquin Valley.

David L. Crow
Executive Director/Air Pollution Control Officer

Northern Region Office
4230 Kiernan Avenue, Suite 130
Modesto, CA 95356-9322
(209) 537-6400 • FAX (209) 537-6475

Central Region Office
1990 East G Street
Fresno, CA 93726-0244
(559) 230-6000 • FAX (559) 230-6061
www.vallevair.org

Southern Region Office
2700 W Street, Suite 275
Bakersfield, CA 93301-2373
(661) 326-6900 • FAX (661) 326-6985
District staff is available to meet with you to discuss air quality issues. If you have any questions or require further information, please call me at (559) 230-5807.

Sincerely,

Dave Mitchell
Supervising Air Quality Planner
May 7, 2001

Bill Zumwalt
Kings County Planning Agency
Government Center
1400 West Lacey Boulevard
Hanford, CA 93230

RE: SCH# 200111133, Revised Dairy Element of the Kings County General Plan

Dear Mr. Zumwalt:

The Native American Heritage Commission has reviewed the above mentioned NOP. To adequately assess the project-related impact on archaeological resources, the Commission recommends the following action be required:

1. Contact the appropriate Information Center for a records search. The record search will determine:
   - Whether a part or all of the project area has been previously surveyed for cultural resources.
   - Whether any known cultural resources have already been recorded on or adjacent to the project area.
   - Whether the probability is low, moderate, or high that cultural resources are located within the project area.
   - Whether a survey is required to determine whether previously unrecorded cultural resources are present.

2. The final stage of the archaeological inventory survey is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
   - Required the report containing site significance and mitigation be submitted immediately to the planning department.
   - Required site forms and final written report be submitted within 3 months after work has been completed to the Information Center.

3. Contact the Native American Heritage Commission for:
   - A Sacred Lands File Check.
   - A list of appropriate Native American Contacts for consultation concerning the project site and assist in the mitigation measures.

Lack of surface evidence of archeological resources does not preclude the existence of archeological resources. Lead agencies should include provisions for accidentally discovered archeological resources during construction per California Environmental Quality Act (CEQA) §15064.5 (f). Health and Safety Code §7050.5 and Public Resources Code §5097.98 mandates the process to be followed in the event of an accidental discovery of any human remains in a location other than a dedicated cemetery and should be included in all environmental documents. If you have any questions, please contact me at (916) 563-4038.

Sincerely,

Debbie Glas-Treadway
Associate Governmental Program Analyst

cc: State Clearinghouse
7 June 2001

Mr. Bill Zumwalt, Director, Kings County Planning Agency  
Government Center Building #6  
1400 W. Lacey Boulevard  
Hanford, CA 93230

REVIEW OF PROGRAM ENVIRONMENTAL IMPACT REPORT (PEIR), REVISED DRAFT DAIRY ELEMENT OF THE KINGS COUNTY GENERAL PLAN (SCH #2000111133)

Thank you for the opportunity to provide comments on the subject PEIR. We have reviewed the revised draft Dairy Element with reference to our water quality requirements and concerns. Our comments are contained in the enclosed memorandum.

We hope our comments are helpful. If you have any questions regarding this matter, please feel free to contact Matt Scroggins at (559) 445-6042.

CLAY L. RODGERS  
Senior Engineering Geologist  
C.E.G. No. 1794

MSS:mss  
Enclosure  
cc: State Clearinghouse, Sacramento
TO: CLAY L. RODGERS  
Senior Engineering Geologist  
C.E.G. No. 1794  
FROM: MATTHEW S. SCROGGINS  
Staff Engineer  
DATE: 7 June 2001  
SIGNATURE:

SUBJECT: REVIEW OF PROGRAM ENVIRONMENTAL IMPACT REPORT (PEIR), REVISED  
DRAFT DAIRY ELEMENT OF THE KINGS COUNTY GENERAL PLAN  
(SCH #2000111133)

The following comments pertain to the subject document and are arranged by section number in ascending order:

1. **SECTION 4.3: WATER RESOURCES; SETTING; WATER QUALITY; SURFACE WATER QUALITY, GENERAL INDUSTRIAL PERMIT (PG. 4.3-8)**

**COMMENT:**

A discussion about the General Waste Discharge Requirements for Milk Cow Dairies (Order No. 96-270) does not seem appropriate in this section. The National Pollutant Discharge Elimination System (NPDES) General Permit (Order No. 97-03-DWQ) is a permit adopted by the State Water Resources Control Board and is implemented throughout the state by the storm water unit at each of the nine regional water quality control boards. It is a completely separate permit and may be issued for a facility regardless of whether Order No. 96-270, a conditional waiver, or individual Waste Discharge Requirements have been issued for a dairy.

2. **SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-3 (PG. 4.3-16)**

The second paragraph in this section says, "Under existing State regulations, confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm event. All precipitation and surface drainage outside of manured areas shall be diverted away from manured areas unless it would be fully retained (CCR Title 27, Division 2, Subdivision 1, 22562(a))."
COMMENT:
This section should look like the following:

Under existing State regulations, confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm event (CCR Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Section 22562(a)). All precipitation and surface drainage outside of manured areas shall be diverted away from manured areas unless it would be fully retained (CCR Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Section 22562(b)).

3. SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-5 (PG. 4.3-20)

COMMENT:
The third paragraph on page 4.3-20 says the same thing as item number two above in this memorandum. The same comment applies.

4. SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-7 (PG. 4.3-33)
The footnote on the bottom of the page cites Lonnie Wass of our office as saying that the estimated salt uptake rate by crops, depending on the type of crop, is approximately 1,200 pounds/acre/year. The footnote then goes on to conclude that the assimilative capacity of the subsurface would be roughly 1,800 pounds/acre/year given that the recommended maximum salt loading rates are 2,000 pounds/acre/year for single-cropped land and 3,000 pounds/acre/year for double-cropped land.

COMMENT:
The salt loading rates of 2,000 pounds/acre/year for single-cropped land and 3,000 pounds/acre/year for double-cropped land are recommended maximum rates for areas where salts have not already impaired groundwater. The assimilative capacity of the subsurface will vary from site to site and in some situations site-specific conditions may warrant reduced loading rates. It should be noted that these maximum loading rates for salts are based on recommendations made by the University of California in the 1970's. Last year, we requested that the University of California establish a committee of consultants to review these salt loading rates as well as other confined animal facility related water quality issues. A committee has since been formed and a review is currently underway.

5. SECTION 5: CEQA STATUTORY SECTIONS, CUMULATIVE IMPACTS, CUMULATIVE WATER QUALITY IMPACTS (PG. 5-17)
The second paragraph on the page states that the water quality regulations for confined animal facilities are presented in Sections 2510 through 2601 in Title 23, Chapter 15 of the California Code of Regulations.

COMMENT:
The confined animal facility regulations are codified in Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Article 1, Sections 22560-22565 of the California Code of Regulations. They were promulgated in 1984 under Title 23 and subsequently moved in 1997 to its current location under Title 27.

**COMMENT:**

This objective says that a "Comprehensive Dairy Process Water Application Plan" shall be prepared while Appendix J (Pg. J-6) refers to the plan as a "Comprehensive Dairy Process Water Disposal Plan." At no time should nutrients be "disposed." Nutrients should only be utilized for beneficial uses and applied at agronomic rates. Therefore, I suggest entitling the plan "Comprehensive Dairy Process Water Application Plan."

7. **APPENDIX A: TABLE NO. 5, SECTION A**

This section indicates that the maximum theoretical herd capacity of the county is 369,383 milk cows (517,136 animal units) and 410,015 head of support stock (324,348 animal units).

**COMMENT:**

The herd numbers in Table 5 do not match the estimated maximum herd numbers listed in the Summary and Project Description sections of the PEIR (pages 2-2 and 3-6). Pages 2-2 and 3-6 indicate the maximum theoretical herd capacity to be 381,980 milk cows (534,772 animal units) and 423,998 head of support stock (335,409 animal units).

8. **APPENDIX B: DEFINITIONS OF TERMS USED IN THE DAIRY ELEMENT (PG. APPENDIX B-2)**

Definition number two defines animal units as follows:

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>AU Factor</th>
<th>Holstein Factor</th>
<th>Equivalent Animal Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cow</td>
<td>1.00</td>
<td>1.4</td>
<td>1.40</td>
</tr>
<tr>
<td>Dry Cow</td>
<td>0.75</td>
<td>1.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Heifers (2 yrs. and older)</td>
<td>0.75</td>
<td>1.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Heifers (1yr. to breeding)</td>
<td>0.70</td>
<td>1.4</td>
<td>0.98</td>
</tr>
<tr>
<td>Calves (3 mo.-1 yr.)</td>
<td>0.40</td>
<td>1.4</td>
<td>0.56</td>
</tr>
<tr>
<td>Baby Calves (less than 3 mo.)</td>
<td>0.25</td>
<td>1.4</td>
<td>0.35</td>
</tr>
</tbody>
</table>

**COMMENT:**

In order to be consistent with our office and the factors used in Table No. 5 of Appendix A, the above table should look like the following:

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>AU Factor</th>
<th>Holstein Factor</th>
<th>Equivalent Animal Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cow</td>
<td>1.00</td>
<td>1.4</td>
<td>1.40</td>
</tr>
<tr>
<td>Dry Cow</td>
<td>0.8</td>
<td>1.4</td>
<td>1.12</td>
</tr>
<tr>
<td>Heifers (2 yrs. and older)</td>
<td>0.73</td>
<td>1.4</td>
<td>1.02</td>
</tr>
<tr>
<td>Heifers (1yr. to breeding)</td>
<td>0.73</td>
<td>1.4</td>
<td>1.02</td>
</tr>
<tr>
<td>Calves (3 mo.-1 yr.)</td>
<td>0.35</td>
<td>1.4</td>
<td>0.49</td>
</tr>
<tr>
<td>Baby Calves (less than 3 mo.)</td>
<td>0.21</td>
<td>1.4</td>
<td>0.29</td>
</tr>
</tbody>
</table>
June 8, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Government Center Building #6
1400 W. Lacey Blvd.
Hanford CA 93230

Subject: Revised Draft Dairy Element of the Kings County General Plan Program Environmental Impact Report

Dear Mr. Zumwalt:

The San Joaquin Valley Air Pollution Control District (District) has reviewed the project referenced above and offers the following comments:

Overall, the Program Environmental Impact Report (PEIR) does a thorough job in addressing the air quality implications of dairy development in Kings County. The District concurs with the impacts identified as significant and unavoidable in the document. The discussion and use of emission factors to quantify the air quality impacts is consistent with the District’s understanding of the current state of knowledge in this field. The District recognizes that current emission factors may be inaccurate, but we must rely on the California Air Resources Board (ARB) and US Environmental Protection Agency (EPA) for emission factors used in the attainment planning process. The District has not taken a position supporting or opposing any alternative emission factors. The District supports the policy initiatives and mitigation measures included in the document to reduce air quality impacts. The proposed program to monitor and evaluate dairies over time to demonstrate the effectiveness of the element in protecting the environment is a critical component of the document.

During the review the District identified two areas of the document that should be updated to reflect more recent information. Clarifying discussion is provided below.

Page 4.3-3 ozone nonattainment discussion. The San Joaquin Valley Air Basin failed to meet the 1999 deadline for attaining the federal ozone standard under its "serious" designation. The US Environmental Protection Agency has redesignated the District as a "severe" nonattainment area. This has triggered a new planning process with a

David L. Crow
Executive Director/Air Pollution Control Officer

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4230 Kiernan Avenue, Suite 130
Modesto, CA 95356-9322
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Central Region Office
1990 East Gathysburg Avenue
Fresno, CA 93726-0244
(559) 230-6000 • FAX (559) 230-6061
www.valleyair.org

Southern Region Office
2700 M Street, Suite 275
Bakersfield, CA 93301-2373
(661) 326-6900 • FAX (661) 326-6985
requirement to attain the ozone standard by 2005. The District will be preparing a new attainment plan over the next year.

Page 4.2-10 carbon monoxide (CO) status. The Fresno Metropolitan area was designated attainment of the state CO standard September 24, 1998. The entire San Joaquin Valley is now in attainment of both state and federal CO standards.

District staff looks forward to working with Kings County to ensure that as new dairies are developed and control technologies are proven, all feasible measures to reduce emissions are introduced. If you have any questions or require further information, please call me at 230-5807.

Sincerely,

Dave Mitchell
Supervising Air Quality Planner
June 8, 2001

Bill Zumwalt, Director, Kings County Planning Agency
Government Center Building #6
1400 Lacey Blvd.
Hanford, CA 93230

Dear Bill:

Enclosed are some comments for the revised draft dairy element of the Kings County General Plan. The comments are intended to be included in the document.

Under *Aerobic Treatment Systems* on page 4.2-17, the following text could be added to the document:

Currently, research is being conducted at the dairy lagoon at California State University, Fresno, through the Center for Irrigation Technology (CIT). Dave Goorahoo, Ph.D., is the principal investigator. The grant-funded study is investigating the feasibility of creating an aerobic dairy lagoon on the surface strata, and lowering the water pH to 6.5 to 7.0. Adequate levels of dissolved oxygen (DO) need to be maintained in order to prevent excessive levels of hydrogen sulfide (H₂S) from forming. The private industry sponsors are Rain-for-Rent and Mazzei Injector Corporation, both of Bakersfield, and Verdegaal Brothers, Inc. of Hanford. The design entails injecting air through a series of floating manifolds and circulating the lagoon water and thereby maintaining the desired level of DO. Sulfuric acid (H₂SO₄) is injected into the flush line as the water is picked up from the lagoon. The treated water is transported hydraulically to the head of the free stall alley, through the manure separator, and back into the lagoon. Acid is only injected during the flush cycles. This process prevents struvite accumulation in the flush lines and cleans the concrete alleys more efficiently. The study includes air monitoring of ammonia and hydrogen sulfide. The university study is investigating the combined process of acidification, circulation, and aeration, and to determine if these procedures can be a Best Management Practice (BMP) for dairy lagoons.

The primary goal of the university study is to determine if lagoon buffering is effective in breaking down manure solids so the manure can be more effectively managed when it is in suspension. Currently there are eight dairy producers in Kings County who have adapted this technology with several modifications.

Hopefully this information will be a worthwhile addition to the document.

Sincerely,

Jim Gregory
June 21, 2001

Mr. Bill Zumwalt  
Kings County Planning Agency  
1400 W. Lacey Boulevard  
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Revised Dairy Element of the Kings County General Plan. Caltrans has the following comments:

Our previous letters dated April 20, 2001 and February 5, 2001, (enclosed) is still applicable. In addition any new of future development within the Dairy Development Overlay Zones will require future review by Caltrans.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

Al Dias  
Office of Transportation Planning  
District 6

Enclosures
April 20, 2001

Mr. Bill Zumwalt
Kings County Planning Agency
1400 W. Lacey Boulevard
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Revised Dairy Element of the Kings County General Plan. Caltrans has the following comments:

Our previous letter dated February 5, 2001, (enclosed) is still applicable. In addition any new of future development within the Dairy Development Overlay Zones will require future review by Caltrans.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

Al Dias
Office of Transportation Planning
District 6

Enclosure
February 5, 2001

Mr. Bill Zumwalt  
Kings County Planning Agency  
1400 W. Lacey Boulevard  
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Program EIR for the Draft Dairy Element of the Kings County General Plan. Caltrans has the following comments:

The cumulative impact of future dairy developments together with other local projects was not considered. The proposed dairy developments coupled with all the other local projects could generate a significant traffic impact that needs to be studied. It would be very difficult to monitor and record the cumulative impact from all the individual and dairy developments on a project-by-project basis. We recommend a mitigation monitoring program, based on the project traffic impacts, be established within this new Dairy Element or amend the Transportation/Circulation Element of the County General Plan per the Public Resources Code, Section 21081.6, Subdivision (a).

Caltrans endeavors to maintain a minimum level of service (LOS) “C” on State highway facilities. Caltrans utilizes the methods outlined in the Highway Capacity Manual determining the level of service for State facilities. Caltrans considers the Florida Tables acceptable for planning purposes. Please consult the “Caltrans Guide for Traffic Impact Studies, January 2001” for details on our LOS recommendations. We request that our staff and your staff meet to discuss methodology and set a scoping meeting.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

[Signature]

Al Dias  
Office of Transportation Planning  
District 6

Enclosure
July 31, 2001

Bill Zunwalt  
Kings County Planning Agency  
Government Center  
1400 West Lacey Boulevard  
Hanford, CA 93230

Subject: Revised Draft Dairy Element of the Kings County General Plan  
SCH#: 2000111133

Dear Bill Zunwalt:

The State Clearinghouse submitted the above named Draft EIR to selected state agencies for review. On the enclosed Document Details Report please note that the Clearinghouse has listed the state agencies that reviewed your document. The review period closed on July 30, 2001, and the comments from the responding agency (ies) is (are) enclosed. If this comment package is not in order, please notify the State Clearinghouse immediately. Please refer to the project's ten-digit State Clearinghouse number in future correspondence so that we may respond promptly.

Please note that Section 21104(c) of the California Public Resources Code states that:

"A responsible or other public agency shall only make substantive comments regarding those activities involved in a project which are within an area of expertise of the agency or which are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation."

These comments are forwarded for use in preparing your final environmental document. Should you need more information or clarification of the enclosed comments, we recommend that you contact the commenting agency directly.

This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act. Please contact the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process.

Sincerely,

Terry Roberts  
Senior Planner, State Clearinghouse

Enclosures
cc: Resources Agency
<table>
<thead>
<tr>
<th>Project Title</th>
<th>Project Location</th>
</tr>
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<tbody>
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<td>[Redacted]</td>
<td>[Redacted]</td>
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</table>

**NOTICE OF COMPLIANCE AND ENVIRONMENTAL DOCUMENT TRANSMITTAL**

Mall of America, 100 East 5th Street, Suite 1213, Minneapolis, MN 55401

The attached documents are submitted in accordance with the requirements of the Minnesota Pollution Control Agency's (MPCA) Permitting Program. The documents include the following:

1. **Project Description:** The proposed project is the [Redacted]. The project is located at [Redacted]. The project will involve [Redacted].
2. **Environmental Impact Statement (EIS):** The EIS contains a comprehensive analysis of the project's potential impacts on the environment. The EIS is available for review at [Redacted].
3. **Dramatic Action Plan (DAP):** The DAP outlines the measures that will be taken to mitigate the project's environmental impacts. The DAP is available for review at [Redacted].
4. **Other Documents:** Additional supporting documents, including [Redacted], are included for completeness.

The submission of these documents is in compliance with the requirements of the Minnesota Pollution Control Agency's Permitting Program. The MPCA will review these documents and provide any necessary comments or conditions for the project to proceed.

[Signature]
[Name]
[Title]
[Date]
**Lead Agency Contact**

<table>
<thead>
<tr>
<th>Name</th>
<th>Bill Zumwalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency</td>
<td>Kings County Planning Agency</td>
</tr>
<tr>
<td>Phone</td>
<td>(559) 562-3211 x 2670</td>
</tr>
<tr>
<td>Address</td>
<td>Government Center</td>
</tr>
<tr>
<td></td>
<td>1400 West Lacey Boulevard</td>
</tr>
<tr>
<td>City</td>
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</tr>
<tr>
<td>State</td>
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<td>Zip</td>
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**Project Location**

<table>
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<th>Kings</th>
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<tbody>
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<tr>
<td>Region</td>
<td></td>
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<tr>
<td>Cross Streets</td>
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<tr>
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<tr>
<td>Township</td>
<td></td>
</tr>
</tbody>
</table>

**Proximity to:**

- Highways
- Airports
- Railways
- Waterways
- Schools
- Land Use

**Project Issues**

- Aesthetic/Visual; Agricultural Land; Air Quality; Archaeologic-Historic; Economics/Jobs; Flood
- Plain/Flooding; Geologic/Seismic; Minerals; Noise; Public Services; Schools/Universities; Soil
- Erosion/Compaction/Grading; Toxic/Hazardous; Traffic/Circulation; Vegetation; Water Quality; Water Supply; Wetland/Riparian; Wildlife; Growth Inducing; Landuse; Cumulative Effects; Drainage/Absorption

**Reviewing Agencies**

- Resources Agency; Department of Conservation; Department of Fish and Game, Region 4;
- Department of Parks and Recreation; Department of Water Resources; Caltrans, District 6;
- Department of Food and Agriculture; Department of Health Services; State Water Resources Control Board, Division of Water Quality; Regional Water Quality Control Board, Region 5 (Fresno); Native American Heritage Commission; State Lands Commission; Other Agency(ies)

Note: Blanks in data fields result from insufficient information provided by lead agency.
7 June 2001

Mr. Bill Zumwalt, Director, Kings County Planning Agency
Government Center Building #6
1400 W. Lacey Boulevard
Hanford, CA 93230

REVIEW OF PROGRAM ENVIRONMENTAL IMPACT REPORT (PEIR), REVISED DRAFT DAIRY ELEMENT OF THE KINGS COUNTY GENERAL PLAN (SCH #2000111133)

Thank you for the opportunity to provide comments on the subject PEIR. We have reviewed the revised draft Dairy Element with reference to our water quality requirements and concerns. Our comments are contained in the enclosed memorandum.

We hope our comments are helpful. If you have any questions regarding this matter, please feel free to contact Matt Scroggins at (559) 445-6042.

CLAY L. RODGERS
Senior Engineering Geologist
C.E.G. No. 1794

MSS:mss
Enclosure

cc: State Clearinghouse, Sacramento
TO: CLAY L. RODGERS  
Senior Engineering Geologist  
C.E.G. No. 1794  

FROM: MATTHEW S. SCROGGINS  
Staff Engineer  

DATE: 7 June 2001  

SIGNATURE:  

SUBJECT: REVIEW OF PROGRAM ENVIRONMENTAL IMPACT REPORT (PEIR), REVISED DRAFT DAIRY ELEMENT OF THE KINGS COUNTY GENERAL PLAN (SCH #200011133)  

The following comments pertain to the subject document and are arranged by section number in ascending order:  

1. SECTION 4.3: WATER RESOURCES; SETTING; WATER QUALITY; SURFACE WATER QUALITY, GENERAL INDUSTRIAL PERMIT (PG. 4.3-8)  

COMMENT:  
A discussion about the General Waste Discharge Requirements for Milk Cow Dairies (Order No. 96-270) does not seem appropriate in this section. The National Pollutant Discharge Elimination System (NPDES) General Permit (Order No. 97-03-DWQ) is a permit adopted by the State Water Resources Control Board and is implemented throughout the state by the storm water unit at each of the nine regional water quality control boards. It is a completely separate permit and may be issued for a facility regardless of whether Order No. 96-270, a conditional waiver, or individual Waste Discharge Requirements have been issued for a dairy.  

2. SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-3 (PG. 4.3-16)  
The second paragraph in this section says, "Under existing State regulations, confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm event. All precipitation and surface drainage outside of manured areas shall be diverted away from manured areas unless it would be fully retained (CCR Title 27, Division 2, Subdivision 1, 22562(a))."
COMMENT:

This section should look like the following:

*Under existing State regulations, confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm event (CCR Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Section 22562(a)). All precipitation and surface drainage outside of manured areas shall be diverted away from manured areas unless it would be fully retained (CCR Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Section 22562(b)).*

3. **SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-5 (PG. 4.3-20)**

**COMMENT:**

The third paragraph on page 4.3-20 says the same thing as item number two above in this memorandum. The same comment applies.

4. **SECTION 4.3: WATER RESOURCES, IMPACTS AND MITIGATION MEASURES, IMPACT 4.3-7 (PG. 4.3-33)**

The footnote on the bottom of the page cites Lounie Wass of our office as saying that the estimated salt uptake rate by crops, depending on the type of crop, is approximately 1,200 pounds/acre/year. The footnote then goes on to conclude that the assimilative capacity of the subsurface would be roughly 1,800 pounds/acre/year given that the recommended maximum salt loading rates are 2,000 pounds/acre/year for single-cropped land and 3,000 pounds/acre/year for double-cropped land.

**COMMENT:**

The salt loading rates of 2,000 pounds/acre/year for single-cropped land and 3,000 pounds/acre/year for double-cropped land are recommended maximum rates for areas where salts have not already impaired groundwater. The assimilative capacity of the subsurface will vary from site to site and in some situations site-specific conditions may warrant reduced loading rates. It should be noted that these maximum loading rates for salts are based on recommendations made by the University of California in the 1970's. Last year, we requested that the University of California establish a committee of consultants to review these salt loading rates as well as other confined animal facility related water quality issues. A committee has since been formed and a review is currently underway.

5. **SECTION 5: CEQA STATUTORY SECTIONS, CUMULATIVE IMPACTS, CUMULATIVE WATER QUALITY IMPACTS (PG. 5-17)**

The second paragraph on the page states that the water quality regulations for confined animal facilities are presented in Sections 2510 through 2601 in Title 23, Chapter 15 of the California Code of Regulations.

**COMMENT:**

The confined animal facility regulations are codified in Title 27, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Article 1, Sections 22560-22565 of the California Code of Regulations. They were promulgated in 1984 under Title 23 and subsequently moved in 1997 to its current location under Title 27.
6. APPENDIX A: OBJECTIVE DE 4.2 (PG. DE-31)

COMMENT:
This objective says that a "Comprehensive Dairy Process Water Application Plan" shall be prepared while Appendix J (Pg. J-6) refers to the plan as a "Comprehensive Dairy Process Water Disposal Plan." At no time should nutrients be "disposed." Nutrients should only be utilized for beneficial uses and applied at agronomic rates. Therefore, I suggest entitling the plan "Comprehensive Dairy Process Water Application Plan."

7. APPENDIX A: TABLE NO. 5, SECTION A

This section indicates that the maximum theoretical herd capacity of the county is 369,383 milk cows (517,136 animal units) and 410,015 head of support stock (324,348 animal units).

COMMENT:
The herd numbers in Table 5 do not match the estimated maximum herd numbers listed in the Summary and Project Description sections of the PEIR (pages 2-2 and 3-6). Pages 2-2 and 3-6 indicate the maximum theoretical herd capacity to be 381,980 milk cows (534,772 animal units) and 423,998 head of support stock (335,409 animal units).

8. APPENDIX B: DEFINITIONS OF TERMS USED IN THE DAIRY ELEMENT (PG. APPENDIX B-2)

Definition number two defines animal units as follows:

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>AU Factor</th>
<th>Holstein Factor</th>
<th>Equivalent Animal Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cow</td>
<td>1.00</td>
<td>1.4</td>
<td>1.40</td>
</tr>
<tr>
<td>Dry Cow</td>
<td>0.75</td>
<td>1.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Heifers (2 yrs. and older)</td>
<td>0.75</td>
<td>1.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Heifers (1yr. to breeding)</td>
<td>0.70</td>
<td>1.4</td>
<td>0.98</td>
</tr>
<tr>
<td>Calves (3 mo.-1 yr.)</td>
<td>0.40</td>
<td>1.4</td>
<td>0.56</td>
</tr>
<tr>
<td>Baby Calves (less than 3 mo.)</td>
<td>0.25</td>
<td>1.4</td>
<td>0.35</td>
</tr>
</tbody>
</table>

COMMENT:
In order to be consistent with our office and the factors used in Table No. 5 of Appendix A, the above table should look like the following:

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>AU Factor</th>
<th>Holstein Factor</th>
<th>Equivalent Animal Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cow</td>
<td>1.00</td>
<td>1.4</td>
<td>1.40</td>
</tr>
<tr>
<td>Dry Cow</td>
<td>0.8</td>
<td>1.4</td>
<td>1.12</td>
</tr>
<tr>
<td>Heifers (2 yrs. and older)</td>
<td>0.73</td>
<td>1.4</td>
<td>1.02</td>
</tr>
<tr>
<td>Heifers (1yr. to breeding)</td>
<td>0.73</td>
<td>1.4</td>
<td>1.02</td>
</tr>
<tr>
<td>Calves (3 mo.-1 yr.)</td>
<td>0.35</td>
<td>1.4</td>
<td>0.49</td>
</tr>
<tr>
<td>Baby Calves (less than 3 mo.)</td>
<td>0.21</td>
<td>1.4</td>
<td>0.29</td>
</tr>
</tbody>
</table>
June 21, 2001

Mr. Bill Zumwalt
Kings County Planning Agency
1400 W. Lacey Boulevard
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Revised Dairy Element of the Kings County General Plan. Caltrans has the following comments:

Our previous letters dated April 20, 2001 and February 5, 2001, (enclosed) is still applicable. In addition any new of future development within the Dairy Development Overlay Zones will require future review by Caltrans.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

Al Dias
Office of Transportation Planning
District 6

Enclosures
April 20, 2001

2135-IGR/CEQA
KIN-GEN
DRAFT DAIRY ELEMENT
OF THE KINGS COUNTY
GENERAL PLAN
SCH# 2000111133

Mr. Bill Zumwalt
Kings County Planning Agency
1400 W. Lacey Boulevard
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Revised Dairy Element of the Kings County General Plan. Caltrans has the following comments:

Our previous letter dated February 5, 2001, (enclosed) is still applicable. In addition any new development within the Dairy Development Overlay Zones will require future review by Caltrans.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

[Signature]

Al Dias
Office of Transportation Planning
District 6

Enclosure
February 5, 2001

Mr. Bill Zumwalt
King's County Planning Agency
1400 W. Lacey Boulevard
Hanford, CA 93230

Dear Mr. Zumwalt:

Thank you for the opportunity to review the Draft Program EIR for the Draft Dairy Element of the Kings County General Plan. Caltrans has the following comments:

The cumulative impact of future dairy developments together with other local projects was not considered. The proposed dairy developments coupled with all the other local projects could generate a significant traffic impact that needs to be studied. It would be very difficult to monitor and record the cumulative impact from all the individual and dairy developments on a project-by-project basis. We recommend a mitigation monitoring program, based on the project traffic impacts, be established within this new Dairy Element or amend the Transportation/Circulation Element of the County General Plan per the Public Resources Code, Section 21081.6, Subdivision (a).

Caltrans endeavors to maintain a minimum level of service (LOS) “C” on State highway facilities. Caltrans utilizes the methods outlined in the Highway Capacity Manual determining the level of service for State facilities. Caltrans considers the Florida Tables acceptable for planning purposes. Please consult the “Caltrans Guide for Traffic Impact Studies, January 2001” for details on our LOS recommendations. We request that our staff and your staff meet to discuss methodology and set a scoping meeting.

If you have any questions, please call me at (559) 488-7306.

Sincerely,

[Signature]

Al Dias
Office of Transportation Planning
District 6

Enclosure
August 15, 2001

Kings County Planning Agency
Kings County Government Center
Hanford, CA 93230

Attention: Bill Zumwalt, Director

Dear Bill,

Please remove my name from the list of members of the Dairy Element Review Committee included in Appendix A of the Revised Draft Dairy Element of the Kings County General Plan.

While it is true that I participated in several public meetings where technical operational and reporting parameters related to dairies were discussed, those meetings occurred more than 6 months prior to preparation of the Program Environmental Report. The committee was not involved in that preparation in any way. Inclusion of the committee in the report erroneously gives the impression of involvement and support. I have serious reservations about this document and cannot support it at this time.

Sincerely,

Bruce R. Livingston, President
August 23, 2001

Mr. Bill Zumwalt, Director
Kings County Planning Department
Kings County Government Center
Hanford, CA 93230

Dear Bill,

This letter is a formal request to have my name removed from Appendix A in the Revised Draft Dairy Element as a member of the Dairy Element Review committee.

Though I indicated an interest and willingness to serve on this committee, I attended one (the first) meeting and only for about 15 minutes as this meeting, and the meetings following, conflicted with another previously scheduled meetings.

I look forward to working on the Final Dairy Element through the Farm Bureau committee, but at this time, it is neither appropriate nor correct for my name to appear on that committee list.

If you have any questions, please feel free to contact me.

Thank you for your prompt attention to this important request.

Sincerely,

Kelly Deming
Executive Director

cc: Board of Supervisors

Serving Agriculture Since 1918 000038
August 24, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Kings County Government Center
1400 W. Lacey Boulevard
Hanford, CA 93230

SUBJECT: Revised Draft Dairy Element of the Kings County General Plan and Program Environmental Impact Report –

Thank you for the opportunity to review the draft Dairy Element and the Program Environmental Impact Report (PEIR). We have the following comments:

1. We fully concur with the finding made in the PEIR that the Fifty-Percent Reduced County Herd Size is the environmentally superior alternative. The “theoretical” capacity is just that and should not be the figure used to cap dairy cattle numbers. It implies an assumption that manure will be applied throughout the Nutrient Spreading Overlay Zone which has not been shown will be the case. Also, its derivation fails to consider nitrogen and salts from other sources such as synthetic fertilizers, biosolids, treated sewage discharged from POTWs, and animal waste from swine and poultry operations.

2. The Dairy Element should recognize the possibility of large volumes of dairy manure being imported from outside of the county. The more out-of-county manure that is applied, the less land will be available for spreading manure from Kings County’s own dairy farms. Also, the environmental impacts of importation should be evaluated by the PEIR. For example, the pressures of urbanization and the environmental problems resulting from years of dairy waste disposal within the Chino Basin have forced the dairy industry there to export its waste. The Draft Manure Management Strategy Report for the Chino Basin, Santa Ana River Watershed, September 1999, presented by the Santa Ana River Watershed Group (SARWG) states in Section 4.3.6:

A second pilot project is under consideration for direct land application of manure to up to 50,000 acres of farmland in Kings County. A large farming operation has available up to 50,000 acres of land suitable for
manure land application. The farmer proposes a year-round project operating 300 days per year at the rate of 1,000 tons of manure per day.

To launch this project the farmer is requesting a three-year project commitment at the rate of $16.00 per ton of manure. The distance between the CBDA and the property in Kings County is approximately 220 miles each way.

3. In the Human Health section, the PEIR should have evaluated the potential environmental impact of nitrates in groundwater as a hazard to public health. The use of nitrate-contaminated drinking water to prepare infant formula can result in a condition known as infant methemoglobinemia or “blue baby syndrome.” Affected infants develop a peculiar blue-gray skin color and may become irritable or lethargic, depending on the severity of their condition. The condition can progress rapidly to cause coma and death if it is not recognized and treated appropriately. A recent article in the journal, Environmental Health Perspectives 108:675-678 (2000), reports on the investigation of two cases of methemoglobinemia in Wisconsin. Both cases involved infants who became ill after being fed formula that was reconstituted with water from private wells. Water samples collected from these wells during the infants’ illnesses contained nitrate-nitrogen concentrations of 22.9 and 27.4 mg/L.

4. Policy DE 1.21 would require a one-half mile buffer between any residential zone (meaning land zoned or designated for residential uses and not individual rural residences) and a dairy facility. However, the Dairy Element provides no background information to justify why that distance should be chosen instead of a greater one. On the contrary, the SJVUAIPCD is quoted on Page 4.2-43 as stating that “dairies located within 1.0 mile of a sensitive receptor could generate odors that may be significant.” Also, a member of our own Department’s staff is quoted on Page 4.8-8: “fly complaints are typically made from residences within 0.5 to 3.0 miles of a dairy (depending on predominant wind direction) with a fly infestation.” Consideration should be given to expanding that buffer zone, perhaps with regard to the prevailing wind direction, which is from the northwest during the fly season.

5. A source should be provided for the statement found on Page DE-10 of the Dairy Element that salt is generated at a rate of 1.29 lb. per day per AU.

6. Calculations of nitrogen loading used in the Dairy Element are based on factors that include 0.56 lbs/AU/day for milk cows and 0.45 lbs./AU/day for support stock. A statement
is made on Page DE-10 that the "dairy process water (liquid manure) and solid manure factors are assumptions used in calculating Nitrogen values based on RWQCB's Fact Sheet 4." However, Fact Sheet 4 contains a footnote no. 2 on Page 2 which references those nitrogen factors by stating that the "following assumptions used in calculating nitrogen values are consistent with assumptions used by staff in Merced County." The primary source for those figures should be cited. It is important that the Dairy Element use the best science available rather than assumptions that were borrowed from someone else's assumptions.

7. Although new dairy facilities would be prohibited in high water table areas, it isn't clear from reading Policy DE 1.2d whether existing dairies there would be permitted to expand. Zones with high water tables are not conducive to the operation of dairy farms, wastewater lagoons or the land application of large volumes of manure due to the impact of salts and nitrates on groundwater quality. Abandoned and poorly constructed water wells serve as conduits for the movement of pollutants from the shallow perched groundwater in those areas to the deeper aquifers we rely upon for domestic, agricultural, and industrial use. Therefore, we strongly recommend that the Dairy Element designate high water table areas as "sensitive areas" where the expansion of existing dairies would be restricted.

8. Policy DE 3.2a A. specifies a depth of at least five feet between the highest recorded groundwater level and the lowest point of the dairy facility. However, what if there are no records available? Instead, it should be based on the anticipated highest groundwater level as determined by a qualified engineer, hydrologist or soil scientist.

9. Policy DE 4.1B.2.g. on Page DE-28 requires that "naturally occurring or imported clayey soils" be used to underlie the corrals and dry manure storage areas. Appropriate criteria should be included to define acceptable clay, e.g. percentage or hydraulic conductivity.

10. Compliance with the requirements in Policy DE 5.1g would be impractical to monitor and should be deleted.
11. It is inappropriate to consider methane emissions to be a significant impact (Impact 4.2-9). First, methane has not been identified as a criteria air pollutant by either the California Air Resources Board (CARB) or the U.S. Environmental Protection Agency (USEPA) nor has it been classified by CARB or USEPA as a toxic air contaminant or hazardous air pollutant. Second, no quantified standards exist to evaluate whether methane emissions are environmentally significant. Third, in pages 4.2-3, 4.2-4, 4.2-44 and 4.2-75, in an attempt to justify considering methane emissions, the author of the draft PEIR cites methane as “the second most significant greenhouse gas (following carbon dioxide) that contributes to global warming.” In that context, as the author rightly points out, methane emissions are only of concern insofar as they contribute to a global adverse environmental condition, i.e. global warming. Since dairy cows are maintained to meet the demand for milk and other dairy products, it is logical to assume that if Kings County’s dairy cattle numbers do not increase, a similar number of cattle would be located somewhere else where their methane emissions would make an identical contribution to greenhouse gases from a global perspective. Finally, it is unclear why the methane emissions would remain a significant and unavoidable impact despite implementation of the several relevant mitigation measures recommended in the PEIR and proposed as policies in the Dairy Element.

12. The Dairy Element would stipulate that a remarkable number of technical plans be submitted with an application for an SPR, i.e. Comprehensive Nutrient Management Plan, Dead Animals Management Plan, Comprehensive Dairy Process Water Application Plan, Livestock Management Plan and Fugitive Dust Control Plan. Coupled with that is a detailed and comprehensive set of monitoring requirements, which are set forth in Section V. The successful implementation of the Dairy Element will depend on the management commitment and technical skills of dairy operators. Towards that end, it is recommended that the Dairy Element require that at least one manager from each new or expanded dairy facility be required to receive appropriate training with periodic refreshers. The Environmental Stewardship Short Course offered by UC Cooperative Extension could be an example of such training.
Again, thank you for the opportunity to review and comment on these documents which are of such importance to the future of Kings County. Please let me know if you have any questions.

Sincerely,

Keith Winkler, REHS
Director of Environmental Health Services
Kings Mosquito Abatement District
Post Office Box 907
Hanford, California
93232

September 7, 2001

Kings County Planning Agency
Government Center
1400 Lacey
Hanford, CA 93230

Dear Mr. Zumwalt:

RE: Revised Draft Dairy Element of the Kings County General Plan.

The Kings Mosquito Abatement District has reviewed the above mentioned project and offers the following comments.

In the second paragraph of impact 4.8-3, in section 4.8, it is stated that the Kings Mosquito Abatement District requires the installation of manure separation pits at all dairy facilities. This statement is inaccurate. While our District does require the dairy operator to eliminate the accumulation of any solids from their wastewater holding ponds, we do not require the use of separation pits. It is the dairy operator's responsibility to utilize the most efficient separator system for his dairy, which may or may not include separator pits.

Therefore, a more accurate statement would be, “The requirements include the installation of a manure separation system at all dairy facilities to limit the amount of manure solids delivered to process water ponds, reducing the potential for excessive floatable materials.”

Please call my office should there be any questions.

Sincerely,

Gary Hyde, Assistant Manager

Member Mosquito and Vector Control Association of California

000044
7 September 2001

Bill Zumwalt, Director, Kings County Planning Agency
Government Center Building #6
1400 W. Lacey Blvd.
Hanford, Ca. 93230


Dear Mr. Zumwalt;

I am pleased to comment on the referenced Report.

My company manufactures selenium additives for animal and poultry feeds and I lost significant business when the US-FDA functionally “deregulated” selenium as a feed additive in 1987. I filed an Objection at that time, repeatedly complained to that Agency and eventually sued arguing the environmental documents (Environmental Impact Assessment and FONSI- Finding of No Significant Impact) used to support deregulation were totally inadequate. In September 1993, I won a favorable administrative decision when the FDA suspended its deregulation until such time the feed manufacturing industry would submit additional information to support the environmental safety of adding higher levels of selenium to feeds.

The AFIA (American Feed Industry Association) instead of developing and submitting the required information lobbied Congress so that in the Fall of 1994 it passed legislation reinstating the deregulation in spite of the lack of environmental information. The information that existed suggested the increase in the permitted addition level of selenium from 0.1ppm to 0.3ppm would have a significant negative impact on many fish species, interfering with their ability to reproduce. As a result, no one has studied the environmental impact of adding selenium to feeds and such addition may have a significant negative environmental impact the extent of which is not known.

Your EIR mentions selenium only on pages 4.3-8 and 4.3-9 but with no discussion of the environmental impact that may be caused as a result of its addition to dairy feeds.

On page 3-6, the EIR indicates a maximum dairy herd of 381,890 cows plus 423,998 head of support stock. On page 4.3-19, the EIR indicates a maximum of 85-lbs. of manure per day per cow. I prefer to simply state a daily feed intake of 22-lbs. (10-kgs) X 400,000 animals = 8,800,000-lbs. of feed consumed each day X 365 days = 3,212,000,000-lbs. of feed consumed each year. If selenium is added to this feed at 0.3 ppm (parts per million) then approx. 864-lbs. of selenium would be added to the environment each year.
If one paints a "worst case scenario", one must assume 100% of this added selenium leaches from the urine and manure of treated animals during one heavy rainfall. The FDA "FONSI" (Finding of No Significant Impact) assumed a 10% leaching and estimated not more than 5 to 7 ppb (parts per billion) would be added to surrounding lake water. The EPA in controlled studies in Iowa had concluded 2 ppb selenium in lake water would interfere with 50% of the reproduction of bluegill fish.

I believe the referenced EIR is inadequate in that it fails to mention the environmental issues surrounding the addition of selenium to dairy feeds and certainly fails to address them. The EIR will be incomplete until research is conducted on this matter.

Thank you for considering my views.

David A. Eisenberg
195 Vasquez Avenue
San Francisco, Ca. 94124

home tel. 1-415-664-2891
To:
Kings County Farm Bureau Dairy
Element Review Committee

Re: Regarding the Draft Dairy Element

We at Pedro Dairy, would like to express our comments. Considering the different policies and the monitoring programs, we say: it is fallacious, impractical, it is an absurd.

As population grows dairy producers also have to grow efficiently and productively.

Please allow me to add:
May God Bless everybody that honestly work so hard to produce delicious food for all our families.

Sincerely,

Pedro Dairy

RECEIVED
21009-19 Ave
SEP 10 2001
Stratford CA 93266

KINGS COUNTY PLANNING AGENCY
Antonio Pedro
September 10, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Government Center Building #6
1400 W. Lacey Boulevard
Hanford, CA 93230

Dear Mr. Zumwalt:

I am writing to comment on the Revised Draft Dairy Element of the Kings County General Plan. The rules proposed for dairies in the future are a significant departure from the way dairies have been regulated in the past. I have many questions and concerns about this. I am concerned about whether all of these things are based on good science or political and social pressure. Many of the things that are proposed in this document are not even in place on university dairies such as at Cal Poly or UC Davis. If the academics haven’t been able to implement these things, how are we supposed to make these things work in our spare time? To sum it up, are we putting the cart in front of the horse? It is stated on page 4.2-24 that USDA ARS acknowledges that a complete understanding of emission and dispersion of gases generated from animal production systems is currently lacking and that the research projects are expected to be completed by 2005. Page 4.2-27 states that an understanding of livestock operation-related air quality issues is limited and that current research is not specifically addressing all of the issues being faced in the southern San Joaquin Valley. Page DE-49 calls for feasible mitigation measures. I question whether many of these technologies are feasible yet. There are so few advanced treatment technologies for manure operating in the whole country and they haven’t had a very good success rate. I also have questions about some issues in the element that seem to relate better to east coast areas than to our arid west coast environment. Specifically, I’m talking about phosphorus concerns, the proposal to divert clean water from roofs, manure storage buildings, and talk of land management practices such as filter strips. The dairy business is very important to our area. It provides good jobs and good economic activity. We are suffering from double digit unemployment and this is an agricultural area. I call for exercising extreme caution in making such very important decisions that will affect all of our futures. Can we afford to make uninformed policy decisions that can maim or even kill an industry and a way of life?

In most reviews by the RWQCB, salt is found to be limiting. Why was it decided to allow for only 50% volatilization of nitrogen? Is this based on good data? It makes a huge difference in the amount of land that a dairy is required to have.
Extensive research has been conducted over the years on animal waste storage ponds to assess the risks involved and to establish standards and guidelines for their construction. Miller et al. (1985)\(^1\) conducted extensive field monitoring of an unlined, earthen storage pond that served to contain wastewater from a 4500 head beef feeding operation. Rowseell et al. (1985)\(^2\) followed up with a laboratory study to determine the degree and rate of scaling that had been observed. The liquid manure from the feedlot animals was centrifuged to remove a portion of the solids. The effluent from the centrifuge was pumped into the pond. Considerable dilution occurred in the pond due to runoff from the surrounding area. Miller et al. considered this pond a severe test of the suitability of unlined earthen manure storage facilities because of the coarse nature of the soil material and the relatively dilute manure. The pond was observed to effectively seal within twelve weeks of addition of manure. It was concluded that the input from this pond had no effect on the downstream water quality and that it is very unlikely that NO\(_3^-\)N contamination of groundwater would occur from such ponds while they are in use. Nitrification, required to convert ammonia to nitrate, only occurs in the presence of oxygen.

Investigations of seal mechanisms demonstrate that physical clogging factors play a major role as long as soil interparticle void effective diameter is sufficiently small to retain all manure solids. (Barrington et al., 1983)\(^3\) The finer the diameter of the soil pores with respect to the manure solids, the more extensive the sealing process. Barrington et al. (1987 a, b)\(^4\) found little correlation between the soil's k value and the extent of the sealing process. The literature has established that the soil acts as a screen rather than a seal, accumulating at its surface an impermeable manure mat. Thus pore size and geometry become more important than k in determining the sealing outcome. Reduction in seepage by manure sealing was stated to be reliable provided that soils have a minimum clay content. Based on all of the above, Barrington and Broughton proposed the following guideline: If soil clay content exceeds 5 or 15%, for ruminant or monogastric animal manures, respectively, effective soil pore diameter values are respected whatever the soil porosity; no further soil testing is required and the reservoir can be constructed using compaction control sufficient for structural stability. (Barrington and Broughton, 1988)\(^5\)

Because nitrification, required to convert ammonia to nitrate, only occurs in the presence of oxygen, nitrate development within clay liners is probably limited. Miller et al. (1985)

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concluded that, with some limitations, unlined earthen manure ponds are environmentally acceptable, even in sandy material. Rowssell et al (1985) concurred, adding that the initial infiltration rate and the length of time required for the seal to develop will be greater for coarser-textured materials.

I believe that the NRCS guidelines that are proposed in the element are conservative based on the research stated above. I don’t believe that the dairy industry has been irresponsible in safeguarding water quality with the standards for dairy lagoons that we have had in the past. I would like to know what reference was alluded to on page 4.3-31 in making the statement, “Pollutants (nitrates and salts) have been documented to migrate through retention ponds and from corral areas at dairies in Merced and Stanislaus counties. I also question the statement on page 4.3-32 saying, “Significant infiltration of process water stored in pits and ponds may occur.”

It seems that much of the new regulations in this EIR are focused on air quality issues. That is not surprising since our area is in nonattainment for PM10 and ozone. I am concerned with the fact that the state regulatory agency in charge of air standards hasn’t addressed these issues with respect to dairies yet. It seems logical to me that the state agency should address these issues before a county takes these issues on. Currently ag is exempt and I submit that the reason for that is because research hasn’t defined the problem completely yet or been able to propose solutions. This is all well illustrated by the fact that the dairy element documentation wasn’t able to cite PM10 emission factors for unpaved dairy corrals. The PM10 estimates for the four scenarios proffered vary by more than an order of magnitude. Can we really make policy on data like this?

I have questions about the methane issue as well. Methane is not regulated and the greenhouse effect is still being disputed. Global warming is far from proven. Page 4.2-13 stated that dairy cattle represent only 2% of the total ruminant livestock methane generated and only 0.4% of the total anthropogenic methane generated in the US. Livestock manure decomposition producing methane accounts for only 7% of the total anthropogenic methane generated in the US. On page 4.2-77, it was stated that to date, a numerical significance criterion for the impact of increases in greenhouse gases has not been established. To sum things up as I see it, it appears that the livestock industry contributes a small proportion of the total methane and nobody is absolutely sure of the effects of methane as a greenhouse gas.

Concerning reactive organic gases, it was stated that emission factors were developed more than ten years ago and are based on limited available data. It appears that anaerobic digesters are being touted as the primary advanced treatment measure to be considered. I question this because of the regulatory status of methane and the doubts on its effects. Also, won’t an engine burning biogas emit reactive organic gases as well? It seems that ROG is a bigger problem than methane yet we seem to be advocating something that will get rid of methane but produce ROG.

Concerning ammonia, it was stated that there are no federal or state standards but that it is a precursor to PM2.5; however, PM2.5 isn’t well studied and specific PM2.5 rules are
not in place either. The draft dairy element also pointed out that commercial fertilizers emit ammonia as well.

Hydrogen sulfide seems to be mired in uncertainty as well. State standards exist but it is unclassified in attainment status. Also, emission factors are currently unavailable.

Air mitigation measures will be required for dairies with over 735 cows. The following methods were outlined as possibilities: bio waste supplements, chemical additives, permeable and impermeable covers, natural crust covers, composting, aerobic treatment, and anaerobic digesters. The draft element discounted most of these measures immediately. Bio waste supplements were deemed questionable. Chemical additives don’t address reduction of gases. Impermeable covers won’t control gases. Natural crust covers are forbidden by mosquito abatement districts. Composting still has ammonia, pretreatment, and equipment emissions and requires a large area. Aerobic treatment is energy intensive, requires significant maintenance, and the volatile solids removal efficiency is not established. Anaerobic digesters have exhaust emissions from equipment and burning biogas. They have never been considered practical in the past. One anaerobic digester was singled out as a success. (Haubenschild) Nevertheless, page 4.2-22 stated that standard testing methods for quantifying the reduction of air pollutants from treated manure (anaerobically or aerobically) is currently not readily available.

How can we propose to make a major policy change with so few proven options and no data as to the outcome of these remedies?

Concerning dust control, it seems that we are lead to believe that we should install sprinklers to suppress dust in corrals but no suggestions are made as to how we should do this without promoting mosquito and fly populations. “Specific measures” to control exhaust emissions from equipment were mentioned without saying what those specific measures were. Also suggestions were made to install temporary windbreaks at the windward side of construction areas. I am having a hard time imagining a practical way to do that. Finally, the element suggested removing manure frequently and in a manner that will minimize dust emissions while elsewhere stating the importance of not disturbing the manure seal in corrals.

The comprehensive dairy water disposal plan (CDWDP) requires a signed agreement between a dairy operator and landowner, even if they are one and the same. Can’t this be streamlined somehow? Similarly, does a wildlife habitat survey need to be done for every dairy that develops on land that has been actively farmed for decades?

I am slightly confused by the statement about bringing existing dairies into voluntary conformance by 2006. If it is a voluntary program, how can it have a deadline?

There will be a tremendous amount of recordkeeping done under these guidelines. Is it absolutely necessary to have to observe and log dust and odor conditions so frequently? Also, the livestock management plan requires a myriad of details to be logged down. I see no bearing on environmental impacts in many of the details requested. I am
concerned that so much time will be required for recordkeeping that I will not be able to manage my business as effectively as necessary to survive.

Respectfully submitted,

Jacob de Jong
September 10, 2001

Mr. Bill Zumwalt
Director, Kings County Planning Agency
Government Center Building #6
1400 W. Lacey Blvd.
Hanford, CA. 93230

Dear Bill,

Thank you for the opportunity to review the draft Dairy Element and Program EIR for Kings County. I recognize the tremendous amount of time that went into this document. You, your staff, and Baseline should be commended for your valiant effort to set out a blueprint to ensure that the dairy industry continues to grow and prosper while protecting public health, safety and the environment. In spite of all the work that has been done, I have some serious concerns about what has been proposed.

There is no question that clean air is a vital resource to protect. Yet the provisions of the Element propose to regulate an entire industry based on sketchy and questionable data. Information used throughout the air quality discussion (section 4.2) of the PEIR to assess impacts and develop mitigation measures does not have the endorsement of the scientific community. The PEIR references data from studies that have not been published or peer reviewed to ensure accuracy. We do not know with any certainty at this time the quantity of air emissions occurring from dairies. Standard methods for sampling air at dairy facilities to make these determinations are only now being developed. To make a finding of significance in the PEIR regarding air quality impacts is presumptuous and unwarranted until accurate means of quantification are available to establish baseline data for air emissions from livestock and their manure. Technologies to address reducing potential adverse air quality effects from livestock are under investigation, but it would be woefully premature to establish policy regulating an industry on issues for which there is a lack of information and complete understanding.

Cooperative Extension Work in Agriculture and Home Economics
U.S. Department of Agriculture, University of California, County of Kings Cooperating
Following are more specific comments or questions relating to the draft Dairy Element:

Section III. Policies for Siting
Policy DE 1.2d addresses high groundwater areas. A statement is made about what would be required for new dairies in those areas, but there is no reference to existing dairies. Can they continue to operate and expand in those areas?

Policy DE 2.1f says that all new dairies have to include a Technical Report in their application. The technical report is a very detailed, comprehensive document that must contain studies, plans and programs to describe the siting, management and operation of the dairy. What about existing dairies (pre-1979)? Will they be required to submit a Technical Report as part of establishing their calculated capacity?

Policy DE 2.2a says that dairies with zoning permits (which means the ones that came in after 1979) are subject to the limits of their current zoning permit. Most of these dairies have expanded, so they will need to establish a calculated capacity too. Is establishing a calculated capacity (based on land owned by July 1, 1998) considered an expansion that would require a site plan review?

Policy DE 4.1 requires a Comprehensive Nutrient Management Plan as part of the Technical Report. Efforts are underway to define a uniform CNM for use in California. Until the details of a uniform CNM are finalized it would be more appropriate to use another term such as a manure nutrient management plan to avoid confusion.

Section IV. Design Criteria
Policy DE 3.2e refers to “developing requirements” to ensure that there is even distribution of manure laden irrigation water on crops to prevent “hot spots”. Who will develop these requirements and will there be review prior to implementation?

Policy DE 4.1a describes components of the comprehensive nutrient management plan that are required as part of the Technical Report. Under Manure Handling and Storage there is a section on “Manure treatments” that says manure must be handled and treated for a number of reasons including the reduction of air emissions. Treatment implies some action other than standard storage, handling and management of the liquid and dry manure. Many various manure treatment options are being studied, but there is currently little information available about real world efficiency, cost effectiveness, etc. for these technologies. The treatment options listed in Appendix J-7 or others may have merit, but until there is a proven track record of how to best manage them on dairies it is premature to require treatment.

Policy 4.2b says that run-off water that does not come into contact with manured areas must be diverted and is not allowed in the lagoon. If a dairy has sufficient capacity in the lagoon...
to handle this run-off, why should it be prohibited from being stored in the lagoon for subsequent use as irrigation water?

Policy DE 5.1e suggests using water to reduce fugitive dust emissions from corrals. Adding water to corral surfaces to reduce dust can increase odors, humidity, and flies thus causing other problems for animals (mastitis, respiratory disease, pinkeye) and people (nuisances).

Section V. Monitoring
The monitoring program that is described which includes inspections, logging, recording and reporting on a daily, weekly, monthly, periodic, seasonal, semi-annual or annual basis (depending on what is being monitored) goes way beyond the realm of being practical for any dairy producer. The required monitoring is unrealistic, burdensome, and will be impossible to implement on many dairy farms.

Minimum standards for monitoring are listed for each area of concern. Will additional standards be forthcoming that will be required over and above the minimum standard?

The requirement for monitoring wells on all dairies is overkill. If all the detailed provisions of the Element are met and complied with to protect the environment and public health, why are monitoring wells required?

The Dairy Monitoring Office and the compliance specialist assigned to administer the program can not possibly do all of the tasks that are described. Creating a new bureaucracy to oversee the work that milk inspectors, RWQCB inspectors, OSHA compliance officers, Fish and Game wardens, CDFA animal health branch personnel and others are already doing is redundant.

Section VI. Conformance Program
The term “legally established” has appeared in a number of places and needs clarification. Are there any illegally established dairies in the county? It seems that any existing dairy is legally established.

More time and lots of money will be required to bring existing dairies into voluntary conformance with current operational standards. 2006 is not realistic. Instead of creating a new Dairy Conformance “certification” program, the California Dairy Quality Assurance Program should be considered. The CDQAP is voluntary program that allows dairy producers to become certified in Food Safety, Animal Health and Welfare and Environmental Stewardship. The program is a collaborative effort by the dairy industry, the University of California and state and federal regulatory agencies. To certify in Environmental Stewardship, producers must attend classes, develop an Environmental...
Stewardship Farm Management Plan, and successfully complete an on-site evaluation by a non-regulatory third party. More than half of the dairies in Kings County have begun the six hours of class room instruction. About 30% (46 of the 149 dairies) have completed the classes and are now eligible for the on-site evaluation leading to certification. Environmental Stewardship classes will be offered again in Hanford on Oct. 15th, 22nd and 29th.

Section VII. Economic Analysis
A glaring omission in the economic analysis is the cost of conforming to the Element. There will be enormous costs for private consultant and attorney fees, facility upgrades and improvements, land purchases, installation and maintenance of record keeping systems, and all the other details related to preparing, implementing, monitoring and reporting the plans and surveys required for the technical reports. The technical report seems to be in reality a mini-EIR.

Sadly, the practical realities for dairy producers have been lost in preparing all of the very specific details of the Dairy Element to prevent lawsuits from environmental groups. One of the stated goals is to ensure that the dairy industry can grow to enhance the economy of Kings County. Adoption of the draft Dairy Element may have the opposite effect. Few dairies will want to build or expand in Kings County when they may be at an economic disadvantage from the cost of complying with the Element. Regulatory mechanisms already exist to ensure that the environment and public health is protected. The level of participation in the voluntary CDQAP Environmental Stewardship program by Kings County dairy producers demonstrates their commitment to ensuring that they comply with all current, applicable environmental laws and regulations. The Element creates excessive requirements that have questionable benefit for dairies, for the environment and for the public.

I hope that you will give careful consideration to these and other comments you receive regarding the draft Dairy Element and Program EIR for Kings County.

Respectfully,

Carol Collar
Farm Advisor – Dairy, Livestock and Forages
UC Cooperative Extension – Kings County

cc: Bruce Roberts, County Director
University of California Cooperative Extension
September 10, 2001

Bill Zumwalt, Director
Kings County Planning Agency
Government Center Building #6
1400 Lacey Boulevard
Hanford, California 93230

Subject: Revised Draft Dairy Element, Kings County General Plan

Dear Mr. Zumwalt:

Thank you for providing the opportunity to review and comment on the Revised Draft Dairy Element of the Kings County General Plan dated May 7, 2001. Western United Dairymen appreciates your concern for maintaining a healthy and vibrant dairy industry in Kings County. We recognize the tremendous amount of effort that your office expended to prepare the document, and are gratified by your personal willingness to meet with us and discuss the issues and concerns important to us.

There are three points of a general nature that we wish to make on our members' behalf:

1. Western United Dairymen is strongly supportive of your efforts to develop a Dairy Element adequate to meet the requirements governing the future of the dairy industry in Kings County. We recognize that you are required to explore all possible environmental implications related to siting new dairies and expansion of existing dairies. We believe you have adequately and thoroughly accomplished that responsibility. We urge that the process you have started now be continued to its logical conclusion.

2. While it is required that Kings County identify and respond to environmental implications implicit in the Dairy Element, existing law and programs providing regulation and mitigation are in place both for air and water quality issues through the Regional Water Quality Control Board and the San Joaquin Valley Air Pollution Control District. It is both important and appropriate that Kings County maintain jurisdiction of these agencies for their respective responsibilities, and avoid regulatory redundancy.
3. No program or regulatory effort will be successful if the requirements are so burdensome that none are able to effectively and economically comply. It is equally important to not anticipate technologies, practices or control methods, to avoid preventing innovation or misdirecting efforts down what may be a politically attractive path, but what is later determined to lack efficacy. Premature endorsement or mandates to utilize a particular technology or methodology might eventually turn out to be wasteful of limited resources and could jeopardize the financial or environmental health of the dairy industry of Kings County.

Western United Dairymen has made several suggestions and requests for changes in the Revised Draft Dairy Element. We have tried to be constructive in our comment, and hope you will be confident we remain available to work with you and your office to reconcile such differences as may arise from our review.

Very truly yours,

Michael L. H. Marsh, CPA
Chief Executive Officer

MM/kb
Western United Dairymen

Comments on the
Revised Draft Dairy Element
of the Kings County General Plan
September 10, 2001

Page DE-14 Policies DE 1.2a and 1.2b:
The language could be somewhat more specific to state that only the new portion of an existing facility is subject to site plan review.

Page DE-14 Policy DE 1.2c:
Consider that with proper grading or floodwater exclusion structures, it would be possible to construct a facility in the 100-year flood zone.

Page DE-15 Policy DE 1.2f:
Restriction on slopes over 5% is too severe. Proper grading design will allow drainage systems to effectively contain runoff. We suggest no restriction on slope is necessary, so long as the facility is able to comply with the requirements of the Regional Board.

Page DE-15 Policy DE 1.2g:
As written, an existing dairy with no option for expansion other than toward a school is effectively prohibited from growth, even if it pre-existed the school. We suggest that further encroachment could be allowed through the conditional use permit process. For instance, expansion of the milking barn itself, or conversion of an open lot to a freestall system may well enhance the dairy as a neighbor to a school, even if it were located somewhat closer. This policy should allow more flexibility, and should recognize the dairy may have been in place before the school existed. We suggest adding if such expansion does not further encroach on the school site to the end of the first sentence of the second paragraph, relating to existing dairies. We also suggest dropping the prohibition of the final sentence beginning with However, under no circumstances... and replacing it with a new sentence as follows: If an existing dairy wishes to expand its facility in a fashion that will further encroach on the non-conforming separation from the school, a conditional use permit will be required.

Page DE-16 Policy DE 1.2h:
Similar to the discussion above, this policy is also too restrictive to dairies that may have pre-existed their dairy neighbor. We suggest dropping the sentence starting with However, under no circumstances... and replacing it as follows: The existing separation shall be maintained to the maximum extent feasible. This will allow planning staff to be flexible, to evaluate each situation on its merits and to accomplish compromise, while retaining the possibility of appeal.
Page DE-17 Policy DE 1.2i:

We are concerned that existing dairies currently outside the half-mile buffer zone may be precluded from necessary expansion were residential uses to intrude into the buffer zone. Here again we suggest dropping the last sentence, which starts with **However, under no circumstances...** and replacing it with **The existing separation shall be maintained to the maximum extent feasible.**

Page DE-17 Policy DE 1.2i:

Existing dairies need to be protected from restrictions on their ability to grow should a "compatibility zone" boundary be extended into conflict with them.

Page DE-18 Objective DE 2.1:

Additional clarity that the Site Plan Review (SPR) applies only to the new portion of an existing facility is needed. We suggest a new sentence as follows: **All new dairies and any new expansion of existing dairies with previously issued zoning permits shall be required to obtain a site plan review (SPR) of the new portion of the facility before construction or operation begins.**

Page DE-18 Policy DE 2.1b:

We suggest substituting **up to** for **below** in the first sentence.

Page DE-19 Policies DE 2.1c and 2.1d:

For additional clarity, both of these policies need to add the words **on the new portion of the facility**, to the end of the first sentence, after **(SPR)** and **SPR** consecutively.

Page DE-19 Objective DE 2.2:

Again, for clarity we suggest substituting the following sentence: **Any new expansion of dairies which were in existence prior to 1979 will require a site plan review (SPR) on the new portion of the facility, except for dairies in the AL-10 zone district, which will require a conditional use permit on the new portion of the facility.**

Page DE-19 Policy DE 2.2a:

Recommend changing **July 1, 1998**, to the date of adoption of this amendment to the Kings County General Plan.

Page DE-21 Policy DE 3.1b:

The terminology **as far as possible** is too severe. Consider using **as far as feasible** as a substitute.

Page DE-22 Policy DE 3.1c:

Here also we are concerned that existing dairies be allowed to expand as needed to remain competitive within the industry and to provide the opportunity for younger generations to become involved in the business. It appears that the current wording of this policy could allow a newly extant rural residential use to preclude a pre-existing dairy from expanding in certain situations and directions. If your sentence could replace the
words not be reduced, with shall be maintained in so far as feasible, we would be more comfortable with this policy.

**Page DE-22 Policy DE 3.1e:**

Consultation with local Native American groups should only be required in the event of discovery of Native American cultural artifacts, not for paleontological or other artifacts of antiquity. Consider adding affecting Native American cultural resources at the end of the final sentence of this policy.

**Page DE-23 Policy DE 3.2c:**

We recommend the minimum setback from domestic water wells be 100 feet. There should be no requirement for setback from irrigation wells, so long as the wells are properly constructed and protected from surface runoff. If other waterways and waters are adequately protected from contaminated runoff, there will be no need for setbacks in these cases either. Our problem with this policy is that irrigation canals and ditches, and roadside drains in some cases may be considered waters of the state. To require a setback in the case of irrigation ditches would be wasteful of the land area and make siting of the facility more difficult. For this policy to mandate adequate protection of these areas from runoff is more appropriate. In Policy 3.4a you require a setback from public right-of-ways of 50 feet and 20 feet. We concur these are appropriate.

**Page DE-24 Policy DE 3.2h:**

The use of the words and modified dairies in the first line could be understood to mean any change, whether or not additional water is to be used. An example would be changing from flushed feed lanes to a flushed free stall setup, or building a new hay barn or commodity shed. Changes such as these could be accomplished without using additional water, so a Hydrologic Sensitivity Assessment is not material in all cases. We suggest a replacement sentence reading: All applicants for new dairies, or expansion of herd numbers beyond the original calculated capacity of existing dairies, shall retain....

**Page DE-25 Policy DE 3.2i:**

Same comment as for policy DE 3.2h. A new sentence could read: All existing water supply wells at a proposed new dairy or expansion of herd numbers beyond the original calculated capacity of an existing dairy site....

**Page DE-25 Policy DE 3.3a:**

We believe the current language in this policy to be much too restrictive. We suggest the Natural Resources Conservation Service is qualified to conduct a wetland and habitat assessment that will meet the requirements of this section, but we do agree that any necessary mitigation plans should be presented for review by your department. The remainder of this section should be dropped.

**Page DE-27 Goal DE 4:**

Western United Dairymen is confident that water quality can be maintained and effective nutrient management to protect water quality can be accomplished through compliance with existing regulation by the Regional Water Quality Control Board. We find the policies of Goal 4 to be redundant to those of the Regional Board, and therefore
unnecessary. We suggest that referencing the requirements of the Regional Board will be sufficient to address Goal 4. Our comments below on the individual policies are intended to demonstrate our concerns with each, but we wish to make it clear that we prefer Goal 4 be rewritten to acknowledge the regulatory responsibilities of the Regional Board and avoid the current redundancies.

We have provided as an attachment, a copy of the Partnership Agreement between the State of California, various federal agencies, the University of California, and the California dairy industry, entitled Dairy Waste Management: An Integrated Approach to Education and Compliance. Western United Dairymen is a committed partner to this agreement. We suggest that voluntary participation by dairymen in the California Dairy Quality Assurance Program is an appropriate response to accomplish environmental stewardship. We hope that Kings County will recognize it as such.

The following comments, as previously indicated, are submitted to identify our concerns with the individual policies as presented for review.

In the statement of Goal DE 4, we suggest the word system is unnecessary, unless you wish to say systems and techniques of nutrient management in your goal statement.

Page DE-27 Objective DE 4.1:

We prefer to use the term Manure Nutrient Management Plan (MNMP) until such time as the Natural Resources Conservation Service (NRCS) has fully developed the parameters of their official Comprehensive Nutrient Management Plan (CNMP). A core working group has recently been formed by the NRCS and is meeting to create a uniform CNMP for use in California, but a true CNMP is yet to be defined. You may wish to reference this policy to the NRCS plan when it becomes available. A CNMP is expected to go beyond the issues of a MNMP in that it will consider such issues as erosion, crop residues and others. A MNMP is considered to be a subset of a CNMP in the recent draft of USEPA's CAFO Rule, although they use the term Permit Nutrient Plan (PNP).

Page DE-27 Policy DE 4.1a:

Suggest changing CNMP to MNMP.

Paragraph A. Delete all after the first sentence, as recent research indicates this particular practice may not be as beneficial as originally expected. We are able to provide a scientific citation at a later date, should you require it.

Paragraph B.1. Some systems and management practices may wish to add additional water to their system for various purposes. If the system and management practices are in place to handle the added water, it should not be prohibited. We suggest adding words so that the first sentence reads: Dairy siting and management practices shall divert clean water from contact with any manured area, unless such water is planned for and captured in the storage system. Such areas include, but are not limited to...

Paragraph B.2.d. Suggest adding or NRCS technician.

Paragraph B.2.i. Stipulate domestic water supply wells and change setback to 100 feet.
Paragraph B.3. Consistent with paragraph B.1, we suggest adding *unless the runoff water has been planned for and is captured in the storage system* at the end of the first sentence of the section.

Paragraph B.4. We would like to change this sentence to read as follows: *Manure shall be handled and treated consistent with evolving and cost effective technology so as to reduce the loss of nutrients*.

Page 29 Policy 4.1b:

We recommend changing *CNMP* to *MNMP* as discussed earlier.

Paragraph B. As technologies and systems for handling manure continue to evolve and respond to environmental requirements, methods of application for utilization of manure nutrients, and the form of the nutrients themselves will change. Your third sentence, beginning with the word *Additionally*, seems to preclude sprinkler irrigation, which in some systems may well become the preferred method of application. We suggest the prior sentence would adequately cover your concern if you added *and minimize volatilization to the extent feasible* at the end. Then the third sentence could be eliminated.

Paragraph C. This paragraph seems to say the same as Policy DE 4.1c. Please refer to comments below.

Page DE-30 Policy DE 4.1c:

We suggest this Policy statement and the preceding paragraph may be rolled together, as their purpose in both cases is to prevent the off-site migration of manure nutrients. However, in rewriting must be taken so as to not preclude the legal runoff of uncontaminated stormwater, or stormwater in excess of a 25-year, 24 hour storm. Additionally, an NPDES permitted dairy is allowed to discharge stormwater in a chronic storm event. Western United Dairymen is willing to provide staff to help work on alternative wording for this Policy at a later date.

Page DE-30 Policy DE 4.1d:

We prefer simply mandating removal in 72 hours by statute, and eliminating the need to present a Dead Animal Management Plan (DAMP) or contract. The part of this Policy appearing on page DE-31 can then be deleted.

Page DE-31 Objective DE 4.2:

We believe that the components of the previously required Nutrient Management Plan adequately provide for much of what appears to be the concern expressed in this objective for adequate land area to utilize the manure nutrients generated by the dairy. This objective, like some that follow, is beginning to become very intrusive into the management systems and practices on a subject dairy. We strongly urge that your Dairy Element set standards and goals, and allow the individual producer the freedom to comply in a manner of his/her own choosing.

Page DE-31 Policy DE 4.2a:

Paragraph A.1. While we appreciate the reasons for your desire for a recordable and enforceable agreement for off-site use of manure, we are most concerned that this
requirement is a major detriment to utilization of manure nutrients by area farmers. Western United Dairymen insists that we must do all we can to encourage the use of manure nutrients on row, tree and forage crops, especially if we can avoid the use of energy intense synthetic fertilizers. The language of this section should be greatly simplified. We suggest the following: If additional land is needed to provide adequate land area to properly utilize the manure nutrients generated by a dairy, adequate assurances that sufficient agreements are in effect shall be provided.

Paragraph A.1.a) through A.1.g): These items are unnecessarily detailed and we would respectfully suggest they be eliminated. They are a serious disincentive for off-site utilization of manure nutrients, as they cast a cloud on title to property.

Page DE-33 Policy 4.2b:

As we currently have no approved control of air emissions using best available control measures (BACM) available to us, we wish to eliminate this part of the sentence. Air emission technology in agriculture is in its infancy, and we are pursuing the necessary research as quickly as possible. We also have concern about the term best available control measures from air regulations being misapplied to water issues by including it in this discussion. BACM ignores cost considerations. We note that in the new draft CAFO rule from USEPA, the term is now called best available technology economically feasible (BAT). The third sentence dealing with clean water diversion should be made consistent with comments submitted for Policy DE 4.1.a. paragraph B.3. by adding: unless such water has been planned for when sizing the lagoon at the end of the sentence.

Page DE-33 Policy 4.3b:

We do not believe it is appropriate to require an Integrated Pest Management Plan (IPM). In October of 2000 Western United Dairymen submitted an application for a Pest Management Alliance research grant to investigate IPM on dairy farms throughout the state. The California Department of Pesticide Regulation did not fund our request, and has been unable to provide the technical support required to further explore and implement IPM on dairies. We suggest replacing the entire section with: The County shall require that dairy operators provide a Pest and Vector Management Plan as part of the Technical Report submitted with each application to either establish a new dairy or expand an existing dairy. The County encourages the implementation of an Integrated Pest Management (IPM) system insofar as it is consistent with currently accepted dairy technology.

Page DE-34 Goal DE 5:

This part of the Revised Draft Dairy Element is where we have the most serious reservations. As currently written, several of the policies are unacceptable. We do not believe it is possible, and it certainly is not feasible, for any dairy to comply with the restrictions and demands presented in parts of this goal. We do not object to Goal DE 5, as stated. We also concur with Policy 5.1a. We do wish to point out air emissions and control strategies for all of agriculture, not just dairies, is an emerging science, and is still in its infancy. Our scientific community is not only unsure of what emissions are actually occurring, but they also are not confident of how much, when, and under what environmental conditions emissions may be a problem. Western United Dairymen does recognize that air emissions are an issue that must be addressed, and we are committed to
pro-active efforts to address air quality, but we must insist that actions be science based. We do not wish to be trapped into utilizing technologies or management schemes that may be currently popular, but may later be demonstrated to be lacking in tangible results.

To demonstrate our concern, at the August 27, 2001 meeting of the Agricultural Technical Committee of the San Joaquin Valley Air Pollution Control District (SJVAPCD), we were informed by Michael Benjamin of the California Air Resources Board (CARB), that the current factor for emissions of Reactive Organic Gases (ROG) from lactating dairy cattle was established at 12.8 pounds/cow/year, from a study done by USDA in 1977. Neither CARB nor USEPA has been able to find the study, and they are therefore unable to verify the parameters of measurement, or the contributing environmental influences such as relative humidity, wind factors, or soil moisture, all important to validate experimental results. An additional study was done on two dairies in Galt, near Sacramento, with results indicating the number was 5.2 pounds/cow/year. A third study was done in the South Coast Air Pollution Control District on five dairies. This study reported that emissions of ROG were negligible. With such conflicting results as reported by these studies, Western United Dairymen is most reluctant to accept definitive regulations without further investigation.

We have provided as an attachment to these comments, a Voluntary (Incentive Based) Air Quality Compliance Program for Production Agriculture, prepared by the Agricultural Air Quality Task Force dated November 10, 1999. We suggest that this document replace the deleted Policies of Goal DE 5, and be referenced by adding a sentence to Policy 5.1a as follows: *New or expanding dairies will be required to comply with regulations regarding air quality as such regulations are adopted and implemented by the San Joaquin Valley Air Pollution Control District (SJVAPCD). The County strongly encourages participation in the Voluntary (Incentive Based) Air Quality Compliance Program prepared by the Agricultural Air Quality Task Force, dated November 10, 1999, until superseded or replaced by District or State Regulatory Law.*

We will comment on individual paragraphs of DE 5, so that our specific concerns with each can be understood, but strongly suggest that it is much more appropriate to reference the regulations and procedures of the San Joaquin Valley Air Pollution Control District (SJVAPCD) rather than developing independent and redundant county requirements based on uncertain anecdotal information. Western United Dairymen submit that a complete rewrite of Goal 5 is necessary. We must make it most clear that our following comments are not to be considered as endorsement of the individual policies as changed, but rather to demonstrate our objections.

**Page DE-34 Policies DE 5.1b and DE 5.1c:**

Western United Dairymen request that these two policies be deleted in their entirety. Several of the practices and technologies for control of air emissions and odors are based on very preliminary and unreplicated science, and as such cannot be defended or trusted. The effort to control suspected air emissions must be considered from a documented and holistic standpoint. Some of the practices required in the objectionable policies actually can be detrimental to efforts to protect water quality. Identifying specific practices or technologies is premature at this point in time. It is most important to not be so restrictive in the effort to meet air quality and permitting challenges that
entrepreneurial innovation is prevented or that control methods established for air issues create adverse impacts on water quality.

Page DE-36 Policy 5.1d:

It does not seem necessary to exceed the requirements of the proposed Regulation VIII of the SJVAPCD. However, if this section should be retained, for additional clarity we would like as deemed necessary changed to if deemed necessary in the last sentence of the text paragraph preceding the numbered items.

Page DE-36 Policy 5.1e:

This policy seems to be adequately covered by the proposed Regulation VIII regarding roadways and travel. It is our understanding movement of cattle is exempt from fugitive dust and PM10 requirements. Therefore we suggest this policy be deleted.

Page DE-37 Policy 5.1f:

The Livestock Management Plan as outlined in Appendix J is unacceptable. It is entirely inappropriate for the Dairy Element to require documentation of management practices such as feeding regimes, genetic selection, feeding schedules, and herd health, as well as the others included in the Draft Plan. In addition, methane emissions from cattle are not well understood at present and control methods are extremely problematic. This policy is unnecessary and unreasonable. We ask that it be deleted.

Page DE-37 Policy 5.1g:

As previously discussed, all that is required is to reference the control strategies of the SJVAPCD.

Page DE-38 Policy 5.1h:

Consistent with the discussion of Policy 5.1e, we suggest this policy be dropped.

Page DE-38 Policy 5.1i:

We recognize that Best Available Control Measures (BACM) are required due to the change in attainment status, but would like to see flexibility to return to Reasonably Available Control Measures (RACM) should attainment status improve. We recommend the second sentence be deleted and the first modified by replacing Best Available Control Measures (BACM) with required control measures. The actual regulatory requirement will then be applied as appropriate by the SJVUAPCD, as required by USEPA.

Page DE-38 Policy 5.1k:

We suggest the policy be shortened to read ...removed or managed. This would eliminate reference to the parts of the element where we have requested deletions.

Page DE-39 Goal DE 6:

We believe Goal 6 should be eliminated and combined with Goal 7.

Page DE-44 Goal DE 7:

Consistent with our recommendation for Goal 6 the following revised wording for Goal 7 is offered: Establish a Dairy Monitoring Program in Kings County by establishing the Kings County Dairy Monitoring Office, housed in the Kings County
Planning Agency, to be charged with monitoring the effectiveness of mitigation measures and environmental protections provided by the Dairy Element of the Kings County General Plan.

The policies and objectives of Goal DE 7 need to be rewritten to provide that information developed by current regulatory agencies be utilized as far as possible to avoid unnecessary duplication of effort. Any required reporting or log keeping should be considered proprietary information and remain on the dairy. We agree that such information should be provided by appointment for review by authorized regulatory agencies, but insist that such information be maintained at the dairy facility, and remain the property of the operator. Any log keeping activities that may subsequently be required should be in the nature of, or related to the occurrence of, a specific event or excursion that may have needed the attention of the operator. Western United Dairymen would appreciate an opportunity to consult with Kings County to further develop the parameters of operation of the proposed Dairy Monitoring Office so that any changes in the Dairy Element resulting from the current review process can be reflected as the Dairy Monitoring Office is created.

Page DE-46 VI:

Again, for purposes of clarity we wish to provide additional wording at the end of the last sentence of the initial narrative paragraph as follows: which will be limited to the actual expansion portion of the facility.

Page DE-46 Objective 8.1:

Consider adding the following sentence: Certification by the California Dairy Quality Assurance Program (attached) shall be considered as equivalent to compliance with any program of conformance that may be developed by Kings County.
DAIRY WASTE MANAGEMENT:
AN INTEGRATED APPROACH TO
EDUCATION AND COMPLIANCE

A partnership agreement between:

the State of California,
various Federal Agencies,
the University of California,
and the
California Dairy Industry

Signing completed
at a ceremony held at
The University of California, Davis campus
September 9, 1999

000068
The California Dairy Quality Assurance Program
(Environmental Stewardship component)

Partnership Agreement Summary

This “Partnership Agreement” is to formalize a cooperative agreement between the California Dairy Quality Assurance Program (CDQAP), the University of California Cooperative Extension (UCCE), the California Department of Food and Agriculture (CDFA), the California Environmental Protection Agency and the State Water Resources Control Board (Cal-EPA-SWRCB), the California Resources Agency and Department of Fish and Game (CRA-DFG), and three organizations within the United States Department of Agriculture: Animal Plant Health Inspection Service (APHIS), the Natural Resources Conservation Service (NRCS), the Farm Services Agency (FSA), and Region 9 of the United States Environmental Protection Agency (US-EPA).

The purpose of this Partnership Agreement is to support the Environmental Stewardship component of the CDQAP as a voluntary, cooperative government and industry education/facility evaluation program. The program's objective is to assist California dairy producers in meeting all federal, state, regional and local requirements relating to manure and nutrient management. The program’s ultimate goal is to help ensure a healthful environment for the people and wildlife of the state of California. The program’s core components include continuing education workshops for producers, the creation of Environmental Stewardship Farm Management Plans tailored to each dairy, and on-site evaluations by a third party.

Each of the participating State and Federal agencies will support the partnership to the extent that it does not conflict with any agency’s statutory and regulatory obligations. The parties to the Partnership Agreement recognize their related interests and by mutual agreement will create a framework to enhance public and environmental health in the State of California. Industry organizations supporting this agreement include: California Dairy Research Foundation, California Farm Bureau Federation, California Manufacturing Milk Advisory Board, California Milk Advisory Board, Milk Producers Council, and Western United Dairymen. Technical support including education and training is being provided by the University of California, Davis.
Environmental Stewardship
Partnership Agreement Signatories

Winston M. Hickox
Winston Hickox Secretary
California Environmental Protection Agency

Mary Nichols
Mary Nichols, Secretary
The California Resources Agency

Walt Petit
Walt Petit, Executive Director
State Water Resources Control Board

Jeff Yong
Jeff Yong, State Conservationist
USDA-Forest Service, Conservation Service

Paul O. Ugstad
Paul O. Ugstad, Area-Vet-In-Charge
USDA Animal Plant Health Inspection Service

Frank C. Diaz
Frank C. Diaz, Chairman
California Manufacturing M.B. Advisory Board

Ray Soza
Ray Soza, President
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Bill Lyon
William (Bill) J. Lyon Jr., Secretary
California Department of Food and Agriculture

Felicia Marcus
Felicia Marcus, Regional Administrator
US Environmental Protection Agency Region 9

Robert G. Hight
Robert G. Hight, Director
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Val Dolcini
Val Dolcini, State Executive Director
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W. R. Gomda
W. R. Gomda, V.P. Ag and Natural Resources
University of California

Bill Pauli
Bill Pauli, President
California Farm Bureau Federation

Bob Feenstra
Bob Feenstra, Executive Director
Milk Producers Council

Charles Ahlem, Chairman
California Dairy Quality Assurance Program

000070
PARTNERSHIP AGREEMENT
between the
CALIFORNIA DAIRY INDUSTRY ORGANIZATIONS
which are members of the
CALIFORNIA DAIRY QUALITY ASSURANCE PROGRAM
(ENVIRONMENTAL STEWARDSHIP COMPONENT)
and
FEDERAL AND STATE AGENCIES

I. Agreement to Establish Partnership

This "Partnership Agreement" (PA) is to formalize a cooperative agreement between the California Dairy Quality Assurance Program (CDQAP), the University of California Cooperative Extension (UCCE), the California Department of Food and Agriculture (CDFA), the California Environmental Protection Agency and the State Water Resources Control Board (Cal-EPA-SWRCB), the California Resources Agency and Department of Fish and Game (CRA-DFG), and three agencies within the United States Department of Agriculture: Animal Plant Health Inspection Service (APHIS), the Natural Resources Conservation Service (NRCS), the Farm Services Agency (FSA); and Region 9 of the United States Environmental Protection Agency (US-EPA).

The term "Partnership," as used in this agreement, is not intended to create a partnership within the meaning of California Corporations Code section 15006, that is, an association of two or more persons to carry on as co-owners a business for profit. No party to this agreement is authorized to enter into any contract or arrangement on behalf of any other party to this agreement in the absence of specific written authorization. Furthermore, it is intended that each party to this agreement shall bear its own liability for its own acts and shall assume no liability for the acts of any other party to this agreement. Industry organizations supporting this agreement include the California Dairy Research Foundation, California Farm Bureau Federation, California Manufacturing Milk Advisory Board, Milk Producers Council, and Western United Dairymen.

The Partnership Agreement will ultimately result in an voluntary, cooperative government and industry environmental stewardship education program. Producers completing this education program will become "certified." The term "certified" or "certification" as used in this agreement, carries no regulatory significance other than to inform local, regional, state and federal agencies of the producer's efforts in meeting compliance. Nothing in this agreement shall be construed as surrendering existing statutory or regulatory authority of any regulatory agency. Nothing in this agreement shall be construed to release a dairy operator from complying with the applicable federal, state, regional or local environmental statutes, regulations, permits, or orders.
The exact policies and procedures by which a producer will become certified will be determined following a pilot program to be coordinated by the California Department of Food and Agriculture (see Section VIII). Other interested parties such as the California Regional Water Boards and the Department of Health Services will be invited to participate in both the pilot program and the development of certification policies and procedures. The policies and procedures will be agreed to by unanimous consent of all partners prior to their implementation.

II. Partnership Purpose and Goals

The purpose of this Partnership Agreement is to support the California Dairy Quality Assurance Program as a voluntary, cooperative government and industry education and facility evaluation program. The program's objective is to assist California dairy producers in meeting all federal, state, regional and local regulations relating to manure and nutrient management. The program's ultimate goal is to help ensure a healthful environment for the people and wildlife of the state of California. The program core components include continuing education workshops for producers, the creation of Environmental Stewardship Farm Management Plans specific to each dairy, and on-site evaluation by a third party. However, third party evaluation and certification is not a determination that a facility is in compliance with environmental laws and regulations.

In order to facilitate the education and certification of the state's dairy producers, all partners in this agreement will cooperate in the development of training materials designed to assist dairy producers into coming into compliance with all federal, state, regional and local environmental rules and regulations. Each of the participating state and federal agencies and industry organizations will support the partnership to the extent that it does not conflict with any agency's statutory and regulatory obligations. The parties to the Partnership Agreement recognize their related interests and by mutual agreement will create a framework to enhance public and environmental health in the State of California.

III. Program Areas and Activities

This agreement sets forth the working arrangements among these agencies and participating industry organizations concerning mutual planning, sharing of information, and training in matters relating to environmental stewardship for dairy producers. Principal considerations will be the enhancement of environmental health through education and sharing of information.

Each of the signatories will support the agreement in the following areas:

a. The primary responsibility of all partners are: 1) to develop training materials designed to assist producers in determining their compliance with all federal, state, regional and local environmental laws and regulations related to dairy manure and nutrient management 2) to communicate and coordinate with each other to assist producers in achieving compliance. A product of this effort will be an environmental compliance check-list and related educational materials for use by dairy producers and their advisors in developing and implementing Environmental Stewardship Farm Management Plans.
b. Each partnering organization will have a primary contact/ coordinator and a backup. Contact information (office / mobile / pager / FAX / electronic mail phone numbers) will be made available to all partners.

c. Planning meetings will be scheduled yearly (or at more frequent intervals if deemed necessary by all parties). Meetings will be scheduled at least 30 days in advance. The purpose of the meetings will be to: (1) share information on related activities within each organization (2) evaluate the effectiveness of the agreement and (3) make recommendations for improving the agreement.

d. Meetings may be requested by any partner to address issues related to the program.

IV. The California Dairy Quality Assurance Program

The California Dairy Quality Assurance Program (CDQAP) will coordinate efforts of the dairy industry, government, and academic partners participating in this agreement. This program is a voluntary state, federal and industry cooperative whose mission is to “… encourage science-based dairying practices which promote the health of the consumer, the environment, and dairy livestock.” Technical assistance for the program is being provided by the University of California, Davis. The program is currently funded by grants from the California Manufacturing Milk Advisory Board. While the food safety and animal health modules of the program are currently under development, environmental stewardship represents the first element of the program to be implemented. Obligations of the public and private signatories of this agreement are limited to the elements of the agreement itself. Participation in this agreement in no way obligates collaborating organizations or individual producers to participate in any other components of the CDQAP (such as the food safety and animal health/welfare modules).

Dairy producers in California may voluntarily choose to become certified by the CDQAP in environmental stewardship. The requirements and benefits of this certification as well as the role each of the organizations participating in this Partnership Agreement will play in the certification process are outlined below. The process by which a producer is certified will be finalized by unanimous consent of all partners following completion of the certification pilot project (see Section I).

V. Requirements for Producer Certification

Participation in the program by a dairy producer is strictly voluntary. These certification requirements are intended to assist the producer in complying with laws and regulations set forth in 1) the California Porter Cologne Water Quality Control Act, 2) the federal Safe Drinking Water Act 3) the federal Clean Water Act 4) the California Fish and Game Code and the 5) federal Coastal Zone Management Act. In order for a producer to become certified in the Environmental Stewardship program, each of the three requirements listed below must be completed.
By participating in this partnership agreement, the signatories to this agreement are not making a determination that producers receiving third party certification are in compliance with applicable laws. However, third party certification is one mechanism by which local, state, and federal regulatory agencies are informed of a producer’s efforts in achieving compliance with environmental laws.

1. **Environmental Stewardship Short Course** - Each producer (or authorized employee representing the dairy) must complete a workshop in environmental stewardship developed or approved by University of California Cooperative Extension (UCCE). Workshops will be held at various locations throughout the state and conducted by UCCE trained staff. Certificates of completion will be provided and records of attendance kept by UCCE.

2. **Environmental Stewardship Farm Management Plan and associated documents** - Each producer (or authorized employee representing the dairy) will complete an Environmental Stewardship Farm Management Plan and other associated documents tailored to his or her dairy. The producer is responsible for developing the farm management plans and the plans shall remain at the facility. A regulatory agency’s authority to gather information, an operator’s right to withhold information and the public’s right to access the information shall be governed by existing laws and regulations.

These plans will include (but are not necessarily limited to):

A. Completed risk assessment documents.

B. Calculations describing current wastewater storage capacity and calculations of storage capacity necessary to prevent discharge from the dairy in the event of a 25-year, 24-hour storm.

C. Calculations demonstrating that existing wastewater capacity is capable of storing contaminated runoff from a 25-year, 24-hour storm and maintain at least two feet of freeboard.

D. A map of the dairy facility and crop land indicating where inappropriate surface discharge and/or groundwater infiltration could occur (a stormwater pollution prevention plan).

E. A narrative describing how surface and groundwater discharges will be prevented. The map and narrative will address: 1) containment of all facility waste water up to and including contaminated rainwater from a 25-year, 24-hour storm event, 2) prevention of washout of storage ponds from a 20-year flood (or 100-year flood for dairies built after November 27, 1984), 3) exclusion of cattle (that are fully or partially on feed and located on anything other than pasture) from entering surface waters (ponds, creeks, etc.), 4) diversion of uncontaminated precipitation and surface drainage from manure or wastewater storage areas, and 5) operation and maintenance practices related to stormwater management.

F. An emergency plan which describes how appropriate resources will be mobilized in the event of a discharge or impending discharge.

G. Documentation that the operator has fulfilled the local, state and federal environmental regulatory requirements.
H. Documentation that the operator meets applicable requirements for dairy storage ponds and land application of manure and wastewater.

1. Other such elements as may be required by the local or regional water quality control board, for example Waste Discharge requirements.

3. Initial On-site Evaluation - The producer (or authorized employee representing the dairy) will participate in an on-site evaluation by a third party. This evaluation will only occur at the request of the producer. A check-list cooperatively developed by the participants in this Partnership Agreement will be used as the evaluation tool. Evaluations will rely heavily on examination of the Environmental Stewardship Farm Management Plan and related documents developed by the producer. The evaluation will include a visual assessment of the waste containment and runoff control facilities. The on-site evaluation will be non-regulatory in nature. Following successful completion of an evaluation, the third party will notify UCCE which will complete the certification process.

In the event that the on-site evaluation reveals circumstances which need to be corrected, the evaluator will leave an itemized list of corrections and will schedule a subsequent re-evaluation. Upon successful completion of the re-evaluation, the third party will notify UCCE, which will complete the certification process.

If a producer owns more than one facility, an employee representing the facilities will only have to attend the Environmental Stewardship Short course once, but a separate Environmental Stewardship Farm Management Plan and associated documents will have to be completed for each facility where livestock are kept.

4. Re-certification - Periodic re-certifications following the third party on-site evaluation protocol described above will be necessary for a producer to maintain his or her Environmental Stewardship Certification as current. The frequency of these re-certifications will be determined as part of the policy and procedure development following the pilot project. In the event that the on-site evaluation reveals circumstances which need to be corrected, the evaluator will leave an itemized list of corrections and will arrange for a subsequent re-evaluation.

5. Quality Control of Evaluation Service - Inspectors from regulatory agencies may sometimes accompany the certification evaluators to observe the quality of the evaluation. A producer has the right not to participate in these joint training exercises. Nothing in this provision limits the ability of a regulatory agency to conduct inspections as authorized by applicable laws.

VI. Obligations of the California Dairy Quality Assurance Program

1. The CDQAP will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.
2. The CDQAP will fund, implement and promote a program which will make Environmental Stewardship workshops available to any producer, regardless of marketing or service organization affiliation. The Environmental Stewardship program has established a goal of having 50% of all producers trained within 24 months of the signing the Partnership Agreement.

3. The CDQAP will fund, implement and promote a program by which any producer, regardless of marketing or service organization affiliation, can voluntarily have his or her facility evaluated and certified.

4. The CDQAP will be the lead organization coordinating of the efforts of the various state, federal, industry and academic partners. This coordination will include, but is not limited to, matters related to training, educational materials, and funding.

5. The CDQAP will be the lead organization responsible for the maintenance of routine communications between the organizations participating in this Partnership Agreement. This will include but is not limited to progress reports, scheduling, and minutes of meetings.

6. The CDQAP will be the lead organization responsible for communication of the goals, requirements and benefits of the Environmental Stewardship program to the state's producers.

VII. Obligations of University of California Cooperative Extension

1. University of California Cooperative Extension (UCCE) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. UCCE will make a dairy environmental workshop available to every dairy producer in California, regardless of marketing or service organization affiliation. The Environmental Stewardship program has established a goal of having 50% of all producers trained within 24 months of the signing of the Partnership Agreement. Attendance by a producer in an educational stewardship short course does not require that he or she participate in an on-farm certification. However, both workshop training and on-site certification are prerequisites for a producer to become certified in the environmental stewardship program. UCCE will work with all partners to ensure that the content of the short course is consistent and current with all federal, state, regional and local environmental regulations.

3. Listings of successful completion by a producer in an environmental stewardship short course and on-site certification will be kept by UCCE and provided to all organizations participating in this agreement. All reports resulting from these data will prominently state that "A dairy's lack of participation or certification in this program does not necessarily imply that the facility is out of compliance with any local, state or federal environmental regulations."

4. With the assistance of the other partners, UCCE will compile a central databank of information regarding environmental regulations, interpretation of those regulations, emerging technologies, and educational materials.
5. UCCE will organize the training of the third party evaluators and assist in conducting quality assurance checks to insure that the on-site evaluations assist producers in meeting all state, federal, regional, and local environmental regulations.

6. UCCE will create and distribute additional materials ("Updates") based on Notices of Violation and Cease and Desist Orders and other information supplied by other partners.

VIII. Obligations of the California Department of Food and Agriculture

1. The California Department of Food and Agriculture (CDFA) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. The CDFA will organize a limited-scale pilot program for third party on-site evaluations. The purpose of this pilot project will be to assess the adequacy of the uniform inspection tool in evaluation of a dairy. CDFA will be assisted in this project by the other partners. Other interested parties such as the California Regional Water Boards and the Department of Health Services will be invited to participate in both the pilot program and the development of the certification policies and procedures. The pilot project is anticipated to take approximately six months. At the end of the pilot project CDFA will report its findings and recommendations back to the partners. At that time, all partners will develop policies and procedures related certification of producers. The policies and procedures will be agreed to by unanimous consent all partners prior to their implementation.

IX. Obligations of the California Environmental Protection Agency and the State Water Resources Control Board

1. California Environmental Protection Agency (Cal-EPA) and the State Water Resources Control Board (SWRCB) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. SWRCB will designate a single representative within its organization to answer questions regarding the appropriateness of specific dairy practices. Responses to these questions will take place within a timely fashion with a goal of a response time of not more than five working days.

3. Cal-EPA and SWRCB will share with other partners changes in policies, guidance and existing regulations at the same time and in the same manner as the rest of the public prior to implementation.

4. Copies of Notices of Violation, Cease and Desist Orders and other regulatory actions will be made available to the partners and the public to the extent authorized by state “sunshine” laws.
after they are finalized and when they are made public. These data will assist the partners in defining future education and training efforts.

5. Cal-EPA and SWRCB will assist UCCE in the creation of environmental stewardship educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

6. Cal-EPA and SWRCB will consider the certification status of a dairy when scheduling routine inspections. The Cal-EPA and SWRCB maintain their authority to enter, inspect or otherwise obtain information regarding any facility in any situation to the extent authorized by the applicable laws for the purposes outlined in those laws. This includes (but is not limited to) complaints or requests for inspections from public sources or private parties, ongoing inspections or compliance orders, or any other reason which leads the Cal-EPA or SWRCB to suspect that a facility is not in compliance with state or federal regulations.

7. Cal-EPA and SWRCB will be the lead entities in coordinating the compilation of inspection protocols related to environmental regulations.

8. Cal-EPA and SWRCB will be the lead entities in coordinating the establishment of a check-list to be used by the third party during on-site evaluation. This evaluation check list will assist third party evaluators in determining whether they believe the facility meets federal, state, regional and local environmental regulations to the extent possible given differences in geographic and regulatory locations. This check list will not interfere with any agency’s statutory obligations. A facility’s compliance with the check list will not constitute any agency certification of compliance with any federal, state, regional or local environmental laws. Cal-EPA and SWRCB will work to make this check list explicit and clear enough for an average producer to understand.

9. Cal-EPA and SWRCB will be the lead entities in the organization of educational workshops designed to train and evaluate employees of the third party on-site evaluation organization in the use of the check-lists described above.

10. Cal-EPA and SWRCB will take any necessary steps to ensure that all agencies under its organizational umbrella, (OEHHA, CIWMB, regional water boards etc.) are aware of and support the obligations undertaken pursuant to this agreement.

X. Obligations of the California Resources Agency and the Department of Fish and Game

1. The California Resources Agency and the California Department of Fish and Game (CRA-DFG) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. CRA-DFG will designate a single representative within its organization to answer questions regarding the appropriateness of specific dairy practices.

3. CRA-DFG will cooperate with other partners in communicating changes in existing laws or regulations or their interpretation to the other partners. CRA-DFG will assist the partners in integrating these changes or interpretations into the uniform dairy evaluation tool.

4. Copies of Notices of Violation, and other regulatory actions will be made available to the partners. These data will assist the partners in defining future education and training efforts.
5. Utilizing the data listed above (paragraphs 2, 3 and 4), CRA-DFG assist UCCE in the creation of educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

6. CRA-DFG will assist Cal-EPA and SWRCB in the processes described above in Section IX, Paragraphs 7, 8, 9. This includes assisting in the establishment of a set of uniform inspection procedures, establishment of a check-list to be used by the third party during on-site evaluation organization, and organization of educational workshops designed to train and evaluate employees of the third party on-site evaluation organization.

7. CRA-DFG will take any necessary steps to ensure that all agencies under its organizational umbrella are aware of and supportive of CRA-DFG's obligations in this agreement.

XI. Obligations of the USDA Animal Plant Health Inspection Service (California office)

1. The USDA Animal Plant Health Inspection Service, Veterinary Services, California office, (APHIS) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. APHIS will assist in providing appropriate personnel and funding when necessary to conduct research projects, educational seminars, and general guidance.

3. APHIS personnel are available as in all cooperative programs to assist in all activities identified for CDFA.

XII. Obligations of the USDA Natural Resource Conservation Service

1. The USDA Natural Resource Conservation Service (NRCS) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. NRCS will continue to provide technical assistance to dairy operators

3. NRCS will continue to pursue additional avenues for technical assistance to dairy operators including the development of the consultant/crop advisor industry.

4. NRCS will continue to participate in the development of technical procedures, training materials and educational materials.
XIII. Obligations of the USDA Farm Services Agency

1. The USDA Farm Services Agency (FSA) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

XIV. Obligations of the US Environmental Protection Agency (Region 9)

1. The United States Environmental Protection Agency, Region 9 (US-EPA), supports the goals and activities of this partnership agreement, to the extent that the agreement does not conflict with US-EPA's authority and obligation to implement federal laws and regulations including laws related to funding and appropriations. The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. US-EPA's access to documents and confidentiality and disclosure of records shall be governed by applicable federal law.

3. US-EPA will designate a lead representative and several alternates to answer questions regarding the appropriateness of specific dairy practices. Responses to these questions will take place within a timely fashion and as quickly as possible.

4. US-EPA will share with other partners changes in policies, guidance and existing regulations at the same time and in the same manner as the rest of the public. Such input shall in no way be construed as surrendering existing statutory or regulatory authority of US-EPA.

5. Copies of Notices of Violation, Administrative Compliance Orders and other regulatory actions will be made available to the partners at their specific request after they are finalized and made public as authorized by the Freedom of Information Act (FOIA). These data will assist the partners in defining future education and training efforts.

6. US-EPA will assist UCCE in the creation of environmental stewardship educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

7. US-EPA will consider the certification status of a dairy when scheduling routine inspections. US-EPA maintains its authority to inspect any facility to the extent authorized by law.

8. US-EPA will coordinate with appropriate State agencies when conducting routine civil inspections. At its discretion, US-EPA may inform crop advisors and other county officials prior to conducting such inspections in their county.

9. US-EPA will be a lead entity in coordinating the compilation of inspection protocols related to environmental regulations.

10. US-EPA will assist in establishing materials (such as an inspection check-list to be used by the third party during on-site evaluation) that will assist the third party evaluator in determining whether they believe the facility is in compliance with applicable environmental statutes. A facility's compliance with a check list will not constitute agency certification of compliance with any federal, state, or local environmental laws.

11. US-EPA will take any necessary steps to ensure that all divisions within the Regional Office are aware of and support the obligations described in this agreement.
XV. General Provisions of the Agreement

1. Obligations of the public and private signatories of this agreement are limited to the elements of the agreement itself. Participation in this Environmental Stewardship agreement in no way obligates collaborating organizations or individual producers to participate in other components of the CDQAP (such as the food safety and animal health/welfare modules).

2. Nothing in this agreement shall be construed as surrendering existing statutory or regulatory authority of any party.

3. Nothing in this agreement shall be construed to release a dairy operator from complying with the applicable federal, state, regional or local environmental statutes, regulations, permits, or consent orders.

4. This agreement may be amended through mutual agreement of the parties.

5. Individual partners may unilaterally withdraw from the partnership agreement following a thirty day notice and explanation of the reasons for withdrawal given at a meeting of the full partnership.
PRODUCTION AGRICULTURE
VOLUNTARY (INCENTIVE BASED) AIR QUALITY COMPLIANCE PROGRAM
Agricultural Air Quality Task Force
November 10, 1999

PURPOSE: Provide recommendations to USDA and USEPA requesting that a voluntary (Incentive Based) Air Quality Compliance Program be developed in accordance with the following guiding principles:

INTRODUCTION

Agricultural field operations are perceived to be significant sources of PM_{10}. In areas that are classified as nonattainment, states are required to bring the areas into attainment in a time frame specified by the Clean Air Act (CAA). If a time line is not met, the state is subject to penalties such as withholding of federal highway funds, offsets, and Federal Implementation Plans (FIPs).

In “moderate” and “serious” nonattainment areas, all area source agricultural operations that are perceived to contribute to the ambient concentration of PM_{10} will be required to implement “Reasonably Available Control Measures (RACMs)” and “Best Available Control Measures (BACMs)”, respectively. No current guidance exists on RACM and BACM for agricultural operations. The difficulties with specifying control measures for area sources of PM_{10} are the lack of good scientific data on the quantity of the PM_{10} reductions associates with specific “RACM/BACM”. In order to appropriately develop guidance for agricultural operations, the following research is needed:

- Define appropriate and effective PM_{10} control measures (potentially RACM/BACMs) for agricultural operations that are economically and technologically feasible;
- Quantify PM_{10} reductions resulting from the utilization of each proposed RACM/BACM; and
- Develop accurate emissions inventories for agricultural operations.

In the interim, States must include in their State Implementation Plans (SIPs) actions that will bring nonattainment areas into attainment within the time frame specified by the CAA. The Agricultural Air Quality Task Force (AAQTF) recommends that the available control measures (potential candidates for RACM/BACM) be based on the Conservation Management Practices (CMP) compiled by USDA.

VOLUNTARY COMPLIANCE PROGRAM RECOMMENDATIONS

The AAQTF considers that voluntary compliance programs are the appropriate strategy for agriculture. The AAQTF is proposing that voluntary compliance programs be used by air pollution regulatory agencies for reductions of PM_{10} from agricultural operations in areas classified as nonattainment. The goal of these voluntary, incentive-based programs is to provide significant reductions of PM_{10} emissions from agricultural operations while sustaining long-term agricultural production. In order for EPA to utilize this policy, the USDA incentive-based programs must include “accountability” and “backstop provisions”. “Accountability” would encompass verification of participation in the program by NRCS of “appropriate agency”. (Farmers will self-certify and NRCS will provide verification of percent application every third year or as appropriate). Accountability would also include adequate record keeping of plans and participation by USDA. “Backstop” would be a failure to achieve participation credited in the SIP which would result in a “SIP Call” and could result in a regulatory approach by the state which could regulate individual agricultural operations.

Although the motivation for this program is to address PM_{10} regulatory procedures, it is anticipated that this voluntary compliance program could also be used for other regulated pollutants attributed to agricultural operations.

As part of this program, the AAQTF proposed the following:

- A guidance document for agriculture production be developed that would include proposed RACM/BACMs and estimated reductions of PM_{10} associated with implementation of each abatement strategy. It is anticipated that RACM/BACM will need to be determined on a site specific basis. (A RACM/BACM may be appropriate for one location and not appropriate for another.) Provisions will be made to facilitate the incorporation of current research findings into this guidance document.
- Local elected officials from the soil and water conservation districts as agreed to in the USDA/EPA Memorandum of Understanding (MOU) may administer the voluntary compliance program with technical assistance, education, and training.

provided by the Natural Resources Conservation Service (NRCS), Cooperative State Research, Education, and Extension Service (CSREES), land grant universities, and the Agricultural Research Service.

- Appropriate resources should be provided to the local soil and water conservation districts and NRCS personnel.
- SIP credits should be allowed based on the rate of participation (percentage of land mass and/or percentage of cooperators participating) and should be based on certification by officials of the conservation district on an annual basis.
- There should be no additional record keeping and reporting requirements on the cooperators beyond that required by the USDA programs.
- The success of this policy will depend upon the states ability to comply with the SIP.
- If agricultural operations are utilizing economically and technologically feasible control measures, the intent of this policy is not to place demands that will result in adverse impacts on those cooperators.
September 10, 2001

William R. Zumwalt
KINGS COUNTY PLANNING AGENCY
Kings County Government Center
1400 West Lacey Boulevard
Hanford, CA 93230

Re: Draft Dairy Element Of The Kings County General Plan

Dear Mr. Zumwalt:

On behalf of a number of clients who are identified at the end of this letter, all of whom are residents of Kings County and members of the local public, I am pleased to submit herewith our comments to the Draft Dairy Element of the Kings County General Plan—Program Environmental Impact Report (“PEIR”).

The PEIR has been examined in light of the following relevant questions:

1. What is the purpose of an Environmental Impact Report as declared under the California Environmental Quality Act (“CEQA”)?
2. What is the standard of findings under CEQA?
3. As to each alleged effect on the environment, does the PEIR meet those standards?
4. Where the PEIR does not meet those standards, what are the consequences under CEQA?

CEQA provides the answer to questions No. 1 and 2:

"(a) The purpose of an environmental impact report is to identify the significant effects on the environment of a project, to identify
alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided.

Therefore, the inquiry under CEQA is whether a project may have significant effects on the environment. CEQA goes on to define "significant effect" as follows:

"Significant effect on the environment means a substantial, or potentially substantial, adverse change in the environment."\(^1\)

Upon what is an EIR to rely in order to make its determinations? CEQA answers that also:

"(c) If a lead agency determines that a proposed project . . . would not have a significant effect on the environment, the lead agency shall adopt a negative declaration to that effect. The negative declaration shall be prepared for the proposed project in either of the following circumstances:

(1) There is no substantial evidence, in light of the whole record before the lead agency, that the project may have a significant effect on the environment.

(e) Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous . . . \(^3\)

\(^1\) Public Resources Code, Section 21002.1; see also 21151.

\(^2\) Public Resources Code, Section 21068.

\(^3\) Public Resources Code, Section 21080; see also 21082.2.
Moreover:

"If, after thorough investigation, a lead agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact." 4

With the foregoing in mind, we have evaluated the PEIR’s treatment of the professed effects of methane, reactive organic gases ("ROGs"), hydrogen sulfide ("H₂S"), ammonia ("NH₃"), and nitrogen oxide ("NOₓ") on air quality, as well as the claimed effects of wastewater lagoons on water quality. Our comments are as follows:

I. AIR QUALITY ISSUES

A. METHANE (CH₃)

The PEIR claims that "[m]ethane has been determined to be the second most significant greenhouse gas (following carbon dioxide) that contributes to global warming," and that "the effects of greenhouse gases have been recognized as a world-wide problem and international efforts are being made to reduce the emission of these gases." (PEIR, p.4.2-3, 4.2-4, 4.2-13). Methane, a product of anaerobic decomposition of organic material, is emitted from many sources, such as wetlands, swamps and marshes. It also comes from livestock—from the anaerobic decomposition of their manure and from the enteric fermentation processes that take place in their digestive systems. 5

The comments in the PEIR about global warming and methane give the impression that these issues are well settled; that the Earth’s atmosphere is warming, that the consequences thereof are adverse to mankind, that dairy cattle are a major contributor to such warming, and that we in Kings County should take steps to mitigate methane production in new and expanding dairies. But is all this true? Are there any reputable scientists, studies, data, or evidence which question or place in dispute any of the foregoing? If there are, the public has a right to expect that the PEIR contains a fair and fulo airing of all such credible evidence.

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4 CEQA Guidelines, Section 15145.

1. GROUND BASED TEMPERATURE READINGS

The initial question which should be raised is what evidence is there that we are indeed experiencing a current warming of global atmospheric temperatures? While the popular media reports that most atmospheric scientists claim average temperature readings have been rising, is it not fair to ask whether the measurements are correct and whether they represent a fair appraisal of what is being experienced on a global basis? According to the National Climate Data Center, the trend line for surface air temperatures taken in the United States over a 103 year period, commencing in 1895 and ending in 1997, reveals a modest increase.\(^6\) One must keep in mind, however, that the foregoing measurements were only taken in the United States, and do not represent temperature measurements taken from throughout the surface of the Earth. The majority of all surface air temperatures have been taken at urban sites, such as at airports and in cities. There are a body of scientists who claim that temperatures taken at urban sites are not truly indicative of overall global conditions. Much of the Earth’s surface consists of vast expanses of oceans, mountains, deserts, forests, and rural farmland, places where few air temperature readings are taken, in comparison to the urban sites where measurements are taken. Temperature reading sites in urban areas are usually surrounded by concrete and asphalt, which is known to absorb solar energy during the day and re-emit it at night. Scientists have given this phenomena the name “urban heat sink islands.” As urban areas have grown over the last 100 years, the urban heat sink island effect would, understandably, become more pronounced and could account for much, if not all, of the small increase in average temperature that some studies show.\(^7\)

2. SEA LEVEL MEASUREMENTS

Some scientists claim that global warming will and is causing the polar ice caps to melt at increasing rates. This is causing rises in sea levels, which they claim will eventually flood cities and

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lowlands situated adjacent to the sea. If indeed we have been experiencing global warming over the last 300 years, as the Earth has emerged from the Little Ice Age, there should be plentiful and consistent evidence of rising sea levels. A research paper prepared in 1992 by a researcher at the National Oceanographic Data Center, NOAA, examined tide gauge measurements since about 1900 from 37 locations throughout the globe. The result showed an average increase in sea level of .001 mm per year, or about .1 mm since 1900. This translates to 4/1000 of an inch in 100 years. At this rate, it will take 2500 years for the sea level to rise 1 inch! If melting ice caps and rising sea levels are indicators of rises in true air temperatures, then such evidence suggests no appreciable global warming.

3. EFFECTS OF SOLAR LUMINOSITY AND VOLCANIC ACTIVITY

Notwithstanding the foregoing, let us assume for the sake of argument that average surface air temperatures, taken on a truly representative basis throughout the Earth, and not influenced by the urban heat sink island effect, do indeed demonstrate a current warming trend. Within the context of world history, is this unusual? Would this automatically mean that it is the result of human activity? It seems undisputed that the Earth has experienced many ice ages and warm periods, repeated cycles of alternating cooling and heating, most of which occurred before man’s activities could have had any hand in it. Such changes have therefore been the work of a multitude of natural forces, many of which are still not clearly understood. Many reputable scientists attribute these cycles to changes in solar output. Various studies have shown a clear and direct correlation between solar luminosity and atmospheric temperature variations. The main exceptions to such correlations have been during periods of unusually high volcanic activity, where immense quantities of ash and dust are put into the upper atmosphere, shading the Earth’s surface from the sun.

4. ARCTIC OCEAN MODEL

Other theories have been developed to explain what causes these natural cycles. For example, there is an oscillating Arctic ice cap hypothesis, called the “Arctic Ocean Model,” which was developed about 30 years ago. It is a model largely ignored, but not discredited, which is still

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endorsed by some scientists today. The ice cap model argues that when the Arctic ice cap is frozen over, the production of new snow and ice falling on the cap is reduced, and the cap begins to shrink. As the ice cap shrinks, the globe experiences warming. When global temperatures rise sufficiently to re-open the Arctic cap, then the exposed Arctic Ocean can once again put more moisture into the atmosphere in the region of the cap, resulting in an increase in snowfall and ice production, which then rebuilds and starts the closing of the gap. This rebuilding of the ice cap begins to cool the Earth’s atmosphere, and the cycle continues to repeat itself.

5. CARBON DIOXIDE: CAUSE OR EFFECT?

It seems that the currently most popular theory is that man’s activity is producing an increase in CO₂ levels in the Earth’s atmosphere, which in turn is contributing to global warming. What is not ordinarily reported in the popular press is that scientists have analyzed data which have shown rises and falls in CO₂ concentrations in the atmosphere. These studies have shown that CO₂ levels have fallen and risen along with evidence of changes in global atmospheric temperatures. But studies have also shown that the rises and falls in temperatures preceded, not followed, the rises and falls in CO₂ levels. In fact, the changes in CO₂ levels lag changes in temperature by five (5) months, suggesting that CO₂ levels were the result of changes in atmospheric temperature, rather than the cause of the same. This means that if a warming is occurring at this time, it would be impossible to show that it is a result of anything other than natural factors.

6. METHANE: SIGNIFICANT OR INSIGNIFICANT?

Let me try to put a finer point on this. The County’s draft PEIR is raising the issue of global warming for one reason only; because it is contending that the methane, emitted by the livestock and manure on new and expanding dairies in Kings County would play a significant role in raising global temperatures, and for that reason the production of methane must be mitigated by them.

Parenthetically, I cannot resist observing that wetlands, marshes, and swamps, known as great producers of methane, seem to still be held in high esteem by environmental scientists. Could it be that there is “politically correct” methane and “politically incorrect” methane?

CEQA provides that an EIR shall set forth "... all significant effects on the environment of

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the proposed project, . . . "Significant effect on the environment" means a substantial, or potentially substantial, adverse change in the environment." While the PEIR makes a qualitative observation that methane is a greenhouse gas, and no one is disputing that, how can the PEIR reach its conclusion that the production of methane by new dairies in Kings County would have a significant impact on global warming without doing any quantitative analysis?

Let us take a moment to look at some quantitative facts:

A basic textbook on environmental geoscience describes the Earth’s atmosphere as consisting of many different gases. 78.084% of the atmosphere is nitrogen and 20.946% is oxygen. These two gases alone account for over 99% of the atmosphere. Argon represents .934%, so these three gases represent 99.964% of the total atmosphere. The remaining gases are as follows:

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>.033%</td>
</tr>
<tr>
<td>Neon</td>
<td>.00182%</td>
</tr>
<tr>
<td>Helium</td>
<td>.00053%</td>
</tr>
<tr>
<td>Krypton</td>
<td>.00012%</td>
</tr>
<tr>
<td>Xenon</td>
<td>.00009%</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>.00005%</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>.00005%</td>
</tr>
<tr>
<td>Methane</td>
<td>.00002% 14</td>
</tr>
</tbody>
</table>

Therefore, according to this textbook, methane is described as the least abundant gas in the atmosphere. At .00002%, methane represents two-tenths of 1 part per 1,000,000, or 1 part per

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12 Public Resources Code, Section 21100(b).

13 Public Resources Code, Section 21058; see also CEQA Guidelines, Section 15382.

5,000,000. If we visualize a railroad boxcar (40' X 8' X 8'), which would hold approximately 164,000 baseballs (3" diameter), then it would take 30 boxcars to hold approximately 5,000,000 baseballs, or a train approximately one-quarter mile long. If those 5,000,000 baseballs represent the molecules of nitrogen, oxygen, argon, carbon dioxide, neon, helium, krypton, xenon, hydrogen, nitrous oxide, and methane in a given volume of atmosphere, then one would find only one methane baseball in that entire train of 30 boxcars; an incomprehensibly and unimaginably small amount. The environmentalists worry that methane in the atmosphere has doubled. If true, that means we have gone from \( \frac{1}{2} \) to 1 methane baseball on that train! Frightening, isn't it?

7. EFFECT OF WATER VAPOR

Dr. Robert Essenhigh, a Professor of Energy Conversion at Ohio State University, recently wrote a letter to the Wall Street Journal in which he observed that 97% of global thermal trapping that occurs in the atmosphere is caused by water vapor, and that only 3% is caused by carbon dioxide. Professor Essenhigh does not even mention methane as a factor.\(^{15}\) Indeed, Professor Essenhigh recently published an article in a peer-reviewed scientific journal in which he states that water vapor is the major heat absorbing gas in the atmosphere, and that CO\(_2\) is the only other significant atmospheric absorbing gas, but only at a minor level. Therefore, by exclusion, Dr. Essenhigh has declared that methane is not a significant atmospheric absorbing gas.\(^{16}\)

Considering the vastness of the globe's atmosphere, and the relative sparseness of methane in it, the mitigation measures proposed in the PEIR to reduce production of methane on new dairies in Kings County seem as foolhardy as prohibiting us from pouring a bucket of water into the ocean so as to reduce a feared rise in sea levels.

8. WOULD THE IMPACT OF GLOBAL WARMING BE ADVERSE?

This brings us to the next element that the PEIR must establish. CEQA provides that an EIR must determine whether or not a proposed project will have "the potential to substantially degrade the quality of the environment" or whether it will "cause substantial adverse effects on human


\(^{16}\) Essenhigh, "Does CO\(_2\) Really Drive Global Warming?" Chemical Innovation Vol. 31 No. 5 May 2001, 44-46.
beings." Again, if we assume for the sake of argument that global warming is occurring, and that the unmitigated production of methane by new Kings County dairy herds will indeed significantly affect the environment, the PEIR then needs to explain how such an effect would degrade the environment or cause a substantial adverse effect on us. Esteemed author H. H. Lamb published a comprehensive book on the history of world climate in 1982, and presented an exhaustive discussion of the cyclic changes in weather during the history of mankind. He observed how changes in weather and changes in average atmospheric temperatures have historically produced both good and bad effects on the environment and on mankind. He characterized the "Medieval Warm Period" in the 1100s and 1200s A.D. as generally beneficial, with milder winters, longer growing seasons, and more abundant food production. This era, which some have referred to as the "Medieval Climate Optimum," experienced temperatures warm enough to allow the colonization of Greenland. Indeed, current global temperature averages still remain lower than those of that era. In contrast, the "Little Ice Age" that followed, centered around 1700, was particularly harsh on mankind and plant and animal life. Lamb's book makes it very clear that changes in temperatures, climate and weather can be good in some respects and bad in other respects, and that different areas of the world are not all similarly affected. Thus, the questions must be asked: What is the "correct" temperature? What is the "optimum" temperature? And for whom or for what? Such questions reveal the complete foolishness and futility of this PEIR even attempting to answer these questions, and of being so arrogant and out of touch with reality as to believe that Kings County should impose costly mitigation measures on methane production without knowing whether such mitigations would achieve anything, and even if they did, without knowing who or what might find it adverse or beneficial.

9. RECOMMEND NEGATIVE DECLARATION FOR METHANE

The PEIR has utterly and completely failed to make its case that the unmitigated production of methane by new dairies in Kings County will have a significant (substantial) adverse effect on the environment or on human beings. It is pure speculation. As mentioned before, the CEQA Guidelines deal with speculation thusly:

"If, after a thorough investigation, a lead agency finds that a particular impact is too speculative for evaluation, the agency should

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17 Public Resources Code, Section 21083 and CEQA Guidelines, Section 15065(d).
19 Lamb, pp. 211-241.
Considering all evidence before the lead agency, I respectfully submit that the lead agency should find the methane effect too speculative to warrant further discussion, or, at the very least, it should issue a negative declaration with respect to methane, by making a finding that unmitigated production of methane by new dairies in Kings County would have an insignificant effect on the environment. Either finding would result in elimination from the PEIR of all of the various measures described therein intended to mitigate methane production.

10. ANALYSIS OF WATER VAPOR VS. METHANE EMISSIONS

Recognizing the possibility that the lead agency will decline to follow the recommendation that I have made above, then, under such circumstances, I believe the PEIR would need to make the following analysis. Since, as mentioned earlier, water vapor is acknowledged by reputable scientists as a leading factor, if not the preeminent factor, in atmospheric thermal trapping, I believe the PEIR would need to evaluate how a proposed dairy project would impact the emission of water vapor into the atmosphere. One must keep in mind that virtually every new dairy project will be constructed on land which was formerly used as irrigated cropland, upon which an average of 3 acre foot of irrigation water would have been customarily applied per acre per year. Therefore, the PEIR would need to consider and evaluate the significance of this conversion of irrigated cropland to dairy facility use. I submit that it would conclude that there would be a dramatic reduction in water vapor production. Although a dairy uses a considerable amount of water, virtually all of that water ends up in the dairy’s wastewater lagoons by way of flushing and draining, and simply becomes part of the irrigation water eventually applied to adjacent cropland. From an atmospheric impact point of view, the only water truly "used" by the dairy project is that which evaporates into the atmosphere. That calculated amount should be compared to the amount of irrigation water formerly "used" by the site when it was irrigated cropland. From a thermal trapping point of view, I am confident that the projected methane emissions from a new dairy would be more than offset by the project’s reduction in water vapor emissions, meaning that a dairy project would result in a net reduction in emissions into the atmosphere of components which play, or may play, a role in atmospheric thermal trapping effects.

B. REACTIVE ORGANIC GASES

The PEIR examines reactive organic gases ("ROGs"), declaring its concern that ROGs are alleged to be precursors to ozone (PEIR 4.2-14). However, the PEIR does not cite its authority for such a claim.

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20 CEQA Guidelines, Section 15145
The PEIR states that the San Joaquin Valley is currently in non-attainment for Federal and State ozone standards. (PEIR 4.2-10). The PEIR includes a table setting forth the results of ozone testing in Kings County, admitting that the only location in the County where ozone levels were measured was in the City of Hanford. Table 4.2-3 asserts that ozone appeared in our local urban air at a concentration of over .12 ppm during 3 days in 1998, during 2 days in 1999, and during no days in 2000. Ozone never exceeded .14 ppm. Thus, ozone appeared in our urban air at a concentration of about 1 part per 10,000,000, but usually less than that.

Just as it would seem inappropriate to take air samples from the end of a truck exhaust, does it not also seem inappropriate to obtain ozone results from only one location in the County, and an urban one at that? Should not such studies seek to collect representative data from throughout the County, rural as well as urban, and to average the results? The PEIR also fails to describe the air sampling and testing protocols followed in connection with these samples, and it fails to assure us that all Federal and State regulations and requirements were complied with in connection with its sampling and testing protocols. Finally, the PEIR does not assert that the results shown in Table 4.2-3 were fairly representative of ozone levels in the County. In the absence of such evidence and assurances, these reputed ozone numbers should be stricken from the PEIR and disregarded.

The PEIR goes on to explain that the intermediate stage of anaerobic decomposition of manure produces volatile fatty acids, aldehydes, alcohols, amines, mercaptans, indoles, and sketol, which the PEIR groups into a category called reactive organic gases (PEIR 4.2-14, 4.2-33). The PEIR further alleges that anaerobic manure decomposition emits ROGs into the atmosphere, basing its claim on a 1988 report done by the Radian Corporation for the Air Resources Board. The PEIR says that the report's ROG emissions "were estimated for existing conditions, assuming that none of the dairy facilities are currently treating generated manure to reduce ROG emissions." (PEIR 4.2-33).

The foregoing assumption is totally false and invalid. One of the resources listed in the PEIR's Bibliography is a research paper, authored by Ruihong Zhang, Associate Professor in the Biological and Agricultural Engineering Department at the University of California, Davis, and entitled "Biology and Engineering of Animal Wastewater Lagoons." Professor Zhang explains that organic acids, amino acids, aldehydes (ROGs), sulfides, and other compounds are intermediate products of the anaerobic decomposition of manure in dairy wastewater lagoons. These intermediate products are dissolved in lagoon water until they are further acted upon by methanogens, acidogens, and other similar bacteria to produce carbon dioxide, methane, ammonia, and hydrogen sulfide as end products, which in turn, bubble to the surface and are emitted into the atmosphere.21

21 Zhang, R., "Biology and Engineering of Animal Wastewater Lagoons," undated, p. 4-6
Professor Zhang makes the important point that wastewater lagoons are "widely used" devices for the "treatment of human, industrial, and animal wastewaters." In other words, dairy wastewater lagoons, which are used on all existing dairies in Kings County and which are a standard part of the construction of new dairy facilities, are "treatments," i.e., mitigations of the emission of ROGs into the air, because the ROGs are transformed into other products before they become atmospheric emissions. "Dry" manure in corrals or wet manure solids applied to fields decompose aerobically, in non-aqueous conditions under which aerobic bacteria degrade the compounds into carbon dioxide, ammonia, and elemental sulfur.\textsuperscript{22}

The PEIR recites that the California Air Resources Board (CARB) has estimated that manure decomposition from Kings County livestock produced eight (8) tons of ROGs per day in 1996, basing its estimate on the emission factors contained in the 1988 report done by the Radian Corporation. (PEIR 4.2-33, 4.2-47, 4.2-48, 4.2-49). The Radian report states, among other things, that "We identified no literature that described organic gas emissions from livestock excrement... In lieu of any new data, we used the same emission factors that were used to calculate the preliminary emission estimates. These are the same emission factors used by the South Coast AQMD [Air Quality Management District] (Halberg, 1984)."\textsuperscript{23}

So, we looked at the 1984 Halberg report referred to above which was done by Earl Halberg, an air quality engineer employed by the South Coast Air Quality Management District. His report says that "[t]he EPA and ARB have not published any emission factors related to the Biological Decomposition of Animal Manures. The only material found to link animal waste to non-point emissions was a report by KVB."\textsuperscript{24}

The KVB report referred to above was prepared in 1978 by KVB, Inc. for CARB. The KVB report declared that "[r]esults from a recent study (Ref. 2-51) were employed to estimate the emission rates from these sources [livestock manure]."\textsuperscript{25} "Ref. 2-51" referred to above was a 1977 paper prepared by Keller and Cowherd. Here is what Halberg had to say about the Keller and

\textsuperscript{22} Zhang, p. 2.

\textsuperscript{23} Radian Corporation, Evaluation of Emissions From Selected Uninventoried Sources, 1988 p. 5-4.

\textsuperscript{24} Halberg, Earl D., Engineering Report on Area Source Emissions From Livestock Waste, 1984, South Coast Air Quality Management District, p. 2.

\textsuperscript{25} KVB, Inc., Control of Hydrocarbon Emissions From Stationary Sources in the California South Coast Air Basins, 1978, prepared for CARB, p. 2-79.
Cowherd source:

"The reference source [Ref. 2-51] quoted in the KVB Report could not be located by the SCAQMD Technical Library Staff," and "[n]one of the emission factors above has been verified by SCAQMD tests and analysis."  

In a nutshell, the PEIR relies on a report (CARB) that relies on a report (Radian) that relies on a report (Halberg) that relies on a report (KVB) that relies on a source (Keller et al) that cannot be found. What makes this matter even more unsettling is that Halberg states that his emission estimates proceed on the assumption that "manures have been allowed to reach their full state of decomposition." These reports make no distinction between manure which decomposes in an anaerobic environment, versus that which decomposes in an aerobic environment, even though Professor Zhang has shown that the compounds produced are different under each. Because of a lack of the "original" source (Keller, et. al.), it is impossible to tell under what circumstances and conditions, and upon what assumptions, the "original" source arrived at its emission estimations. It is disgraceful that the PEIR failed to either notice or comment on the errors, flimsiness, and uncertainty of the basis upon which these ROG emission estimates are used in the PEIR.

Therefore, for all of the reasons enumerated above, the PEIR's amount of estimated ROGs estimated to be emitted into the air by existing dairies must be disregarded as being without sufficient foundation. The PEIR fails to credibly quantify the amount of ROGs emitted into the air from the kinds of dairy manure treatment systems presently used in the County. The PEIR fails to explain the chemical processes which allegedly transform ROGs in the air into ozone, and it fails to explain under what circumstances such transformation would occur, in what quantities, and how much that would be expected to change the concentration of ozone in our local air. Until credible studies and data can be produced which show that dairy facilities, as they are built and operated, will significantly increase the amount of ozone in the Valley, then the PEIR cannot legitimately conclude that new or expanding dairies in Kings County would, from an ozone standpoint, produce a significant adverse impact on local air quality.

C. HYDROGEN SULFIDE (H2S)

The PEIR analyzes hydrogen sulfide, a rotten egg smelling compound that is produced during the anaerobic decomposition of manure. It points out that Section 5155 of Title 8 of the California Code of Regulations specifies that for protection of human health, a person should not be exposed
to concentrations of $H_2S$ in excess of 10 ppm. (PEIR 4.2-36). It says $H_2S$ can be detected in concentrations as low as .01 ppm, but suggests that it is not perceived as offensive until it reaches 3 ppm. (PEIR 4.2-12). The PEIR goes on to report on a 1998 study of 58 Minnesota dairies, where the study found “that the median concentration of hydrogen sulfide at or near the facility boundary was typically less than .02 ppm.” (PEIR 4.2-36). This demonstrates the capacity of such compounds to dilute and diffuse throughout the atmosphere. This also tells us that the Minnesota experience was 1/150 of the levels considered offensive. Notwithstanding the PEIR’s inclusion of such facts, it still concluded that the projected emissions of hydrogen sulfide by new and expanding dairies in the County would have a significant adverse effect on air quality, which should be mitigated. While the PEIR says the Minnesota study may not be applicable to our local situation, the PEIR fails to produce any credible evidence or data that $H_2S$, as it leaves a dairy facility boundary on an unmitigated basis, would be in concentrations high enough to be perceived or to represent a significant adverse effect on air quality.

D. **AMMONIA (NH$_3$)**

In addressing ammonia, the PEIR notes that NH$_3$ can be detected by the human nose at concentrations as low as 5 ppm but irritations do not begin until they reach 100 ppm. It also claims that NH$_3$ is a precursor to PM$_{2.5}$. (PEIR 4.2-12) That manure decomposition produces ammonia is not disputed. Zhang’s paper includes NH$_3$ as a compound produced in anaerobic lagoons.  

While the foregoing observations may be a good starting point, the PEIR fails to complete the analysis. It fails to answer the next logical questions: As air leaves a dairy facility, at what concentration is ammonia? Is it at irritating or even detectable levels? Lacking evidence needed to answer these questions, how can the PEIR justify its finding that ammonia emissions by new and expanding dairies will have a significant adverse effect on air quality for which the dairyman must take steps to mitigate? I believe ammonia levels while still on the dairy facility is only a “workplace” issue, to be dealt with by CAL OSHA.

As the PEIR does its analysis, the studies, research, and data from which it makes its evaluations must relate to the circumstances under which manure is treated and decomposes in the manure handling systems used on dairies today. It must recognize that most manure produced on a modern dairy is “treated” in an anaerobic lagoon. It is further subjected to elements of aerobic treatment when it is pumped from the lagoon and aerated as it flushes feed lanes. Whatever manure solids remain will decompose aerobically when they are applied wet or dry to nearby fields. In the absence of such careful analysis, the conclusions and recommendations made by the PEIR, as they relate to ammonia, are without merit and inappropriate.

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28 Zhang, p. 5.
As I leave the subject of methane, ROGs, hydrogen sulfide and ammonia behind, I cannot resist parenthetically observing that all of these emissions are not only the products of anaerobic decomposition of manure; they are also the natural products of the anaerobic decomposition of other dead and decaying plant material in swamps, marshes, and other wetlands, areas which are revered, promoted, and protected by environmentalists.

E. **NITROGEN OXIDE (NO<sub>x</sub>)**

The PEIR mentions nitrogen oxide (NO<sub>x</sub>), claiming it is a precursor to ozone, and that it is generated by "mobile sources, solvents and fuel combustion." (PEIR 4.2-10) Table 4.2-3 does not claim that NO<sub>x</sub> levels in the City of Hanford exceeded State or Federal standards during any days in the last three (3) years. The PEIR never says that NO<sub>x</sub> is a product of manure decomposition. (See 4.2-29-37). Yet, the PEIR requires that a new or expanding dairy must submit to the County a Manure Treatment Management Plan under which manure is to be treated to reduce NO<sub>x</sub> emissions, among other things (PEIR 4.2-40 and 4.2-68). If the PEIR is serious about this, where is the evidence in the record that establishes that manure decomposition, as it occurs in current dairy systems, on an unmitigated basis, produces sufficient NO<sub>x</sub> to significantly affect ozone levels in the County? If there is no such evidence, treatment of manure to reduce NO<sub>x</sub> emissions must be deleted from the PEIR.

F. **ODORS.**

To the extent that odors produced by dairies are caused by methane, ROGs, hydrogen sulfide, and ammonia, I have already submitted my comments above. To the extent, however, that dairies produce odors caused by other products, the EIR has failed to include any evidence or data whatsoever about any such other products. Therefore, in the absence of such, the PEIR should conclude that such evidence is unavailable and/or too speculative, and that no further discussion or mitigations shall be proposed. The County already has in place "buffer zone" requirements to mitigate odor problems with neighbors.

G. **AIR QUALITY MITIGATIONS**

Because the PEIR simply has insufficient credible evidence to show that emissions coming from new and expanding dairies in the County may have a significant effect on air quality, the PEIR should make a finding of insignificant effect, and eliminate consideration of new mitigations for these alleged emissions. Although that is our most fundamental objection to the air quality mitigation sections of the PEIR and the proposed Dairy Element, there are other reasons to criticize the PEIR's treatment of the subject of mitigations.
We have found the proposed mitigations to be ill-considered, ill-analyzed, and ill-reasoned. They lack analysis of whether the adverse air quality effects of the mitigation measures themselves are as great or greater than the alleged air quality problems they purport to mitigate. For example, the PEIR proposes applying water to unpaved corrals to suppress fugitive dust. (PEIR 4.2-41). Yet, the PEIR fails to mention or evaluate the environmental effect of the water vapor emissions resulting from the water spraying in terms of increased humidity or thermal trapping effects. As another example, the PEIR proposes manure management procedures to reduce emissions from manure decomposition. (PEIR 4.2-67). Yet, it fails to mention or evaluate whether the amount of exhaust emissions from the equipment performing these procedures would be more troublesome to air quality than would be the amount of emissions these procedures were intended to reduce. Boiled down to its most basic, the question should have been whether the "cure" was worse than the "disease." The PEIR fails to cite or include facts or evidence that these mitigations will meaningfully accomplish what they purport to.

The PEIR fails to adequately analyze its proposed mitigations from the standpoint of their economic feasibility, with one exception. It does address the issue of digester and methane recovery systems, where it expresses concern about whether digesters are economically feasible. (PEIR 4.2-20). As to its other significant mitigations, such as use of chemical additives, lagoon covers, composting, and aerobic treatment, it does not examine whether they would be economically feasible. In order to be an economically viable concern, a dairy must be able to successfully compete on a level playing field with the many existing dairies in the state. With such issues in mind, the PEIR needs to estimate the additional costs of implementing each mitigation measure, and should compare it to the absence of such costs by the many existing dairies in the state which are not subject to these mitigation requirements. The PEIR needs to assess whether the additional costs would be significant enough to make the new operation uneconomic. This brings us to the next difficult aspect of economic feasibility. Such evaluations are highly dependent on assumptions and projections which may turn out to be false. Let us not forget that very recently "experts" were predicting widespread rolling blackouts and $3.00 per gallon gasoline this summer in California. Need I say more?

In conclusion, we dare not enslave new dairies with costly and burdensome servitudes for which the need therefor or the efficacy thereof has not been clearly made.

II. WATER QUALITY ISSUES

Protection of the County's surface and groundwater is the responsibility of and regulated by the Central Valley Regional Water Quality Control Board ("RWQCB"). For many years, the Kings County Planning Agency issued Conditional Use Permits for new dairies, specifying that the dairy must receive a Report of Waste Discharge permit from RWQCB, as one of its conditions. Such
permits obligate the dairy to comply with and operate under all state and federal rules and regulations intended to protect surface and ground water. RWQCB has over thirty years of experience in working with and monitoring dairies and should be familiar with what steps and procedures are needed to protect our water resources. In view of this, the PEIR and Dairy Element portion of the County’s General Plan does not need to propose any mitigations or requirements relative to surface and ground water protection which are the same as, depart from, or are in addition to, what is required by the RWQCB. All that is needed is for the Dairy Element to require all new and expanding dairies to obtain waste discharge permits from RWQCB. Otherwise, the County’s intrusion into this area will only result in unnecessarily duplicative requirements, at best, and confusing or conflicting ones, at worst. RWQCB has clearly pre-empted the subject matter, into which the County should not tread. Thus, with respect to the matter of water quality considerations, the PEIR and the Dairy Element should merely specify that new and expanding dairies must comply with all State, Federal, and RWQCB rules and regulations relative to protection of our water resources.

III. STATEMENT OF OVERRIDING CONSIDERATIONS

"CEQA requires the decision-making agency to balance, as applicable, the economic... benefits of a proposed project against its unavoidable environmental risks when determining whether to approve the project. If the specific economic... benefits of a proposed project outweigh the unavoidable adverse environmental effects, the adverse environmental effects may be considered 'acceptable.'" 29

Therefore, let us examine some economic data relevant to Kings County. For the year 2000, the national unemployment rate was 4.0%, the State of California’s was 4.9%, and Kings County’s was 14.0%, ranking it 53rd out of California’s 58 counties. This was not a one-year aberration, as Kings County’s rate was 13.1% in 1999, 13.8% in 1998, 13.1% in 1997, and so on. 30 Indeed, Kings County’s 2000 unemployment rate was higher than the highest unemployment rate ever experienced by the nation since 1940, at the onset of the nation’s involvement in World War II. 31 The San Joaquin Valley’s per capita income in 2000 was $20,364.00, compared to the Bay Area’s $41,129,

29 CEQA Guidelines, Section 15093(a).
30 Employment Development Department ("EDD"), Labor Market Information.
less than half.\textsuperscript{32}

Many people would agree that Kings County is so depressed economically that it is obligated to do its utmost to attract new employment opportunities to the county. Leprino is presently building a new cheese plant west of Lemoore, creating the need for milk from 100,000 cows. But construction of new dairies has come to a standstill, stopped by a Bay Area organization's concern about what new dairies would do to our local environment. Let us examine what a new dairy does for the economy. Each new 3000 cow dairy would bring $10,000,000.00 of new revenue to the County's economy each year in terms of milk and beef income. Each such new dairy will provide year-round, full-time employment for at least 30 families. And all of the foregoing does not take into account the multiplier effect—the new jobs created to haul and process the milk, to grow the feed and provide the other supplies and services that each new dairy will need.

While the bulk of my comments have been dedicated to showing how and why new dairies will not have a significant effect on air or water quality, I suspect there will be those who still disagree. But for those who disagree, it would be difficult for them to deny that this County's economic distress is of such magnitude that the environmental concerns pale in comparison. They should be willing to agree that the environmental effects are "acceptable," as provided in Section 15903 of the Guidelines.

Very truly yours,

\begin{flushright}
GRISWOLD, LaSALLE, COBB,
DOWD & GIN, LLP.
\end{flushright}

By: MICHAEL E. LaSALLE

MEL:mjd
Attachment: Appendix of Technical Papers.
Clients represented:

Gary Esajian
Robin Martella
Neves Farms
Newton Farms and Newton Brothers
Westlake Farms
Wood Bros.

\textsuperscript{32} Johnson, H., Public Policy Institute of California, from data from Federal Bureau of Economic Analysis.
APPENDIX

TO

GRISWOLD, LaSALLE, COBB, DOWD & GIN, L.L.P.

P.E.I.R. COMMENT LETTER

DATED SEPTEMBER 10, 2001

TAB NO.


9  Essenhigh, R., Letter to Editor, *Wall Street Journal*, October 10, 2000; see

Zhang, R., "Biology and Engineering of Animal Wastewater Lagoons," undated, p. 4-6


KVB, Inc., *Control of Hydrocarbon Emissions From Stationary Sources in the California South Coast Air Basins*, 1978, prepared for CARB, p. 2-79.


Employment Development Department ("EDD"), Labor Market Information.
EPA U.S. Methane Emissions 1990 – 2020: Inventories, Projections, and Opportunities for Reductions

Natural Gas Systems

Coal Mining

Emissions Forecast

Landfill

Greenhouse Gas Emissions

Livestock Manure Management

Marginal Abatement Curves

Enteric Fermentation
1. Introduction and Aggregate Results

Introduction

This report has two objectives. First, it presents the U.S. Environmental Protection Agency’s (EPA’s) baseline forecast of methane emissions from the major anthropogenic sources in the U.S., and EPA’s cost estimates of reducing these emissions. Emission estimates are given for 1990 through 1997 with projections for 2000 to 2020. The cost analysis is for 2000, 2010, and 2020. Second, this report provides a transparent methodology for the calculation of emission estimates and reduction costs, thereby enabling analysts to replicate these results or use the approaches described herein to conduct similar analyses for other countries.

The information presented in this report can be used in several ways. The emission estimates and forecasts represent the most up-to-date estimates of methane emissions in the U.S.; thus, this report replaces and expands upon EPA’s Anthropogenic Methane Emissions in the United States, Estimates for 1990, Report to Congress (1993a). As such, this report can be used where estimates of future emissions are required. The report also summarizes the state of knowledge on methane emissions from the major anthropogenic sources.

While the emission estimates are refinements of earlier approaches, the cost analyses presented in this report represent a major contribution to the literature on mitigating emissions. To date, most economic analyses of greenhouse gas (GHG) emission reductions have focused on the energy-related carbon emissions since carbon dioxide (CO2) currently accounts for about 82 percent of the total U.S. emissions (weighted by 100-year global warming potentials) (EPA, 1999). The cost-estimates for reducing methane emissions presented in this report can be integrated into economic analyses to produce more comprehensive assessments of total GHG reductions. By including methane emission reductions, the overall cost of reducing GHG emissions in the U.S. is reduced. At increasing values for emission reductions, more costly CO2 reductions can be substituted by lower cost methane reductions, when available, thereby lowering the marginal cost and the total cost of a particular GHG emission reduction level.

The marginal abatement curves (MACs) developed in this report can be used to estimate possible emission reductions at various prices for carbon equivalent emissions or conversely, the costs of achieving certain amounts of reductions. EPA recognizes that the cost analyses will change with the introduction of new technologies and additional research into methane emission abatement technologies. Other countries, nevertheless, can use the cost analyses presented in this report as the basis for estimating emission reduction costs.

1.0 Overview of Methane Emissions

Next to carbon dioxide, methane is the second largest contributor to global warming among anthropogenic greenhouse gases. Methane’s overall contribution to global warming is significant because, over a 100-year time frame, it is estimated to be 21 times more effective at trapping heat in the atmosphere than carbon dioxide. As illustrated in Exhibit 1-1, methane accounts for 17 percent of the enhanced greenhouse effect (IPCC, 1996a).1

Over the last two centuries, methane’s concentration in the atmosphere has more than doubled from about 700 parts per billion by volume (ppbv) in pre-industrial times to 1,730 ppbv in 1997 (IPCC, 1996a). Exhibit 1-1 illustrates this trend. Scientists believe these atmospheric increases are largely due to increasing...
emissions from anthropogenic sources. Although atmospheric methane concentrations continue to rise, the rate of increase appears to have slowed since the 1980s. If present trends continue, however, atmospheric methane concentrations will reach 1,800 ppbv by 2020 (Dlugokencky et al., 1998).

Atmospheric methane is reduced naturally by sinks. Natural sinks are removal mechanisms and the greatest sink for atmospheric methane (CH₄) is through a reaction with naturally-occurring tropospheric hydroxyl (OH). Methane combines with OH to form water vapor (H₂O) and carbon monoxide (CO), which in turn is converted into carbon dioxide (CO₂). Atmospheric methane, nevertheless, has a clearly defined chemical feedback that decreases the effectiveness of the hydroxyl sink. As methane concentrations rise, less hydroxyl is available to break down methane, producing longer atmospheric methane lifetimes and higher methane concentrations (IPCC, 1996a).

On average, the atmospheric lifetime for a methane molecule is 12.2 years (± 3 years) before a natural sink consumes it (IPCC, 1996a). This relatively short lifetime makes methane an excellent candidate for mitigating the impacts of global warming because emission reductions could lead to stabilization or reduction in methane concentrations within 10 to 20 years.

### 2.0 Sources of Methane Emissions

Methane is emitted into the atmosphere from both natural and anthropogenic sources. Natural sources include wetlands, tundra, bogs, swamps, termites, wildfires, methane hydrates, and oceans and freshwaters. Anthropogenic sources include landfills, natural gas and oil production and processing, coal mining, agriculture (livestock enteric fermentation and livestock manure management, and rice cultivation), and various other sources. By 1990, anthropogenic sources accounted for 70 percent of total global methane emissions (EPA, 1993a; IPCC, 1996a). This section summarizes the natural and anthropogenic sources of methane.

#### 2.1 Natural Methane Emissions

In 1990, worldwide natural sources emitted 916 million metric tons of carbon equivalent (MMTCE) or 160 Teragrams (Tg) of methane into the atmosphere, or about 30 percent of the total methane emissions (IPCC, 1996a). The leading natural methane sources are described below in descending order of their contribution to emissions (see Exhibit 1-2).

- **Wetlands.** Methane is generated by anaerobic (oxygen poor) bacterial decomposition of plant material in wetlands. Natural wetlands emit about 659 MMTCE
(115 Tg) of methane per year, which is 72 percent of natural emissions and 20 percent of total global methane emissions (IPCC, 1995). Methane emissions from wetlands will probably increase with global warming as a result of accelerated anaerobic microbial activity. In addition, climate change models predict increased precipitation as global temperatures rise, which could create more wetlands (EPA, 1993b). Tropical wetlands (between 20° N and 30° S) represent 17 percent of total wetland area and 60 percent of emissions from wetlands. These relatively high emissions are due to higher temperatures, more precipitation and more intense solar radiation, which encourage higher plant growth and decomposition rates (EPA, 1993b).

Northern Wetlands (those above 45° N) are usually underlain with near-surface permafrost that prevents soil drainage and creates wetland conditions. Northern wetlands represent nearly 80 percent of the wetland area and 35 percent of methane emissions from wetlands (EPA, 1993b).

Termites. Microbes within the digestive systems of termites break down cellulose, and this process produces methane. Emissions from this source depend on termite population, amounts of organic material consumed, species, and the activity of methane-oxidizing bacteria. While more research is needed, some experts believe that future trends in termite emissions are more influenced by anthropogenic changes in land use, i.e., deforestation for agriculture, than by climate change. Termites emit an estimated 115 MMTCE (20 Tg) of methane each year (IPCC, 1995).

Oceans and Freshwaters. The surface waters of the world’s oceans and freshwaters are slightly supersaturated with methane relative to the atmosphere and therefore emit an estimated 57 MMTCE (10 Tg) of methane each year (IPCC, 1995). The origin of the dissolved methane is not known. In coastal regions it may come from sediments and drainage. It also has been suggested that methane is generated in the anaerobic gastrointestinal tracts of marine zooplankton and fish (EPA, 1993b). Methane in freshwaters can result from the decomposition of wetland plants. (In this report, methane emissions from freshwaters are included in the estimates for wetlands.) As atmospheric methane concentrations increase, the proportion of methane supersaturated in oceans and freshwaters will decline relative to the atmospheric concentrations of methane, assuming that the methane concentration in oceans and freshwaters remains constant.

Gas Hydrates. Methane is trapped in gas hydrates, which are dense combinations of methane and ice located deep underground and beneath the ocean floor. Recent estimates of hydrates suggest that around 44 billion MMTCE (7.7 billion Tg) of methane is trapped in both oceanic and continental gas hydrates (DOE, 1998). Scientists agree that increasing temperatures
will eventually destabilize many gas hydrates, but are unsure about the timing and the amount of methane emissions that would be released from the deeply buried hydrates (EPA, 1993b).

Permafrost. Small amounts of methane are trapped in permafrost, which consists of permanently frozen soil and ice. (To be classified as permafrost, the ice and soil mixture must remain at or below 0° Celsius year-round for at least two consecutive years.) Due to the large amount of existing permafrost, the total amount of methane stored in this form could be quite high, possibly several thousand Tg (EPA, 1993b). This methane is released when permafrost melts. However, no estimates have been made for current emissions from this source.

Wildfires. Wildfires are primarily caused by lightning and release a number of greenhouse gases, including methane which is a product of incomplete combustion. However, no estimates are available for methane emissions from this source.

2.2 Anthropogenic Methane Emissions

Methane emissions from anthropogenic sources account for 70 percent of all methane emissions and totaled 2,150 MMTCE (375 Tg) worldwide in 1990 (IPCC, 1996a). The leading global anthropogenic methane sources are described below in descending order of magnitude. The two leading sources of anthropogenic methane emissions worldwide are livestock enteric fermentation and rice production. By contrast, in the U.S., the two leading sources of methane emissions are landfills and natural gas and oil systems (see Exhibit 1-3). In 1997, the U.S. emitted 179.6 MMTCE (31.4 Tg) of methane, about 10 percent of global methane emissions for that year (EPA, 1999). The U.S. is the fourth-largest methane emitter after China, Russia, and India (EPA, 1994).

Enteric Fermentation. Ruminant livestock emit methane as part of their normal digestive process, during which microbes break down plant material consumed by the animal into material the animal can use. Methane is produced as a by-product of this digestive process, and is expelled by the animal. In the U.S., cattle emit about 96 percent of the methane from livestock enteric fermentation. In 1994, livestock enteric fermentation produced 490 MMTCE (85 Tg) of methane worldwide (IPCC, 1995), with the emissions coming from the former Soviet Union, Brazil, and India (EPA, 1994). EPA estimates that U.S. emissions from this source were 34.1 MMTCE (6.0 Tg) in 1997 (EPA, 1999). Under EPA's baseline forecast, livestock enteric fermentation emissions in the U.S. will increase to about 37.7 MMTCE (6.6 Tg) by 2020 (Exhibit 1-4). The projected increase is due to greater consumption of meat and dairy products.

Rice Paddies. Most of the world's rice, including rice in the United States, is grown on flooded fields where organic matter in the soil decomposes under anaerobic conditions and produces methane. The U.S. is not a

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**Exhibit 1-3: U.S. Methane Emissions**

Weighted by Global Warming Potential

- Methane 10%
- Nitrous Oxide 6%
- HFCs, PFCs, SF, 2%
- Carbon Dioxide 82%

Total = 1,814 MMTCE

Source Breakdown of 1997 U.S. Methane Emissions

- Landfills 37%
- Natural Gas and Oil 20%
- Enteric Fermentation 19%
- Livestock Manure 10%
- Other 4%

Total = 179.6 MMTCE
### Exhibit 1-4: Baseline Methane Emissions in the United States (MMTCE)

<table>
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<td>1.7</td>
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<tr>
<td>Coal Mining</td>
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<td>30.4</td>
</tr>
<tr>
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<td>17.0</td>
<td>18.4</td>
<td>22.3</td>
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<tr>
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<td>37.7</td>
</tr>
<tr>
<td>Other*</td>
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<td>7.4</td>
<td>7.8</td>
<td>7.6</td>
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<tr>
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<td>179.6</td>
<td>173.9</td>
<td>186.3</td>
<td>185.7</td>
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</table>


*b These estimates developed by EPA for the 1997 Climate Action Report (DOS, 1997).

Totals may not sum due to independent rounding.

Major producer of rice and therefore emits little methane from this source. Worldwide emissions of methane from rice paddies were 345 MMTCE (60 Tg) in 1994 (IPCC, 1995), with the highest emissions coming from China, India, and Indonesia (EPA, 1994). EPA estimates U.S. emissions from this source at 2.7 MMTCE (0.5 Tg) in 1997 and expects emissions to remain stable in the future (EPA, 1999).

**Natural Gas and Oil Systems.** Methane is the major component (95 percent) of natural gas. During production, processing, transmission, and distribution of natural gas, methane is emitted from system leaks, deliberate venting, and system upsets (accidents). Since natural gas is often found in conjunction with petroleum, crude petroleum gathering and storage systems are also a source of methane emissions. In 1994, natural gas systems worldwide emitted 230 MMTCE (40 Tg) of methane and oil systems emitted 88 MMTCE (15 Tg) of methane (IPCC, 1995). EPA estimates that 1997 U.S. emissions were 595 MMTCE (11.6 Tg) in 1997 (EPA, 1999). The baseline forecast is 411 MMTCE (7.2 Tg) from U.S. landfills in 2020 (Exhibit 1-1). Landfill methane is the only U.S. source that is expected to decline in the baseline over the forecast period. This decline is due to the implementation of the New Source Performance Standards and Emissions Guidelines (the Landfill Rule) under the Clean Air Act (March 1996). While the Landfill Rule controls greenhouse gas emissions that form tropospheric ozone (smog), it also will lead to lower methane emissions. The Landfill Rule requires large landfills to collect and combust or use landfill gas emissions.

**Coal Mining.** Methane is trapped within coal seams and the surrounding rock strata and is released during coal mining. Because methane is explosive in low concentrations, underground mines install ventilation systems to vent methane directly to the atmosphere. In 1994, coal mining produced 170 MMTCE (30 Tg) of methane worldwide (IPCC, 1995). EPA estimates that U.S. emissions from this source were 18.8 MMTCE

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U.S. Environmental Protection Agency – September 1999

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Page 3
The ROLE of the SUN in CLIMATE CHANGE

Douglas V. Hoyt
Kenneth H. Schatten
The thermometer used could change due to replacement for breakage or aging. This problem is less likely now than 100 years ago.

The thermometer shelter could change, either through design or condition. Identical thermometers placed in different shelters next to each other can give different readings. Replacing an entire network of shelters might produce an apparent regional climatic shift, although none actually occurred. The shelters need not even be replaced to produce such erroneous events. Shelters are painted white and if the brand of paint is changed for the entire network from an oil-based to a latex pigment, the paint's emissive properties might cause a shift in the mean temperatures. The effect would be the same as a change in shelter structure, but would be more difficult to track. Careful records are made of changes in shelter design, but no records may be kept of changes in the kind of paint used.

Even small changes in thermometer location and surroundings can cause an apparent change in climate. About 1930, in Denver, the thermometer was moved from the first to the second floor. During the following years, the recorded temperatures decreased slightly and cold records increased significantly. This change might easily be missed by analysts seeking climate changes. Another change might occur simply because a nearby tree or group of trees subtly altered the local heat balance and downwind temperature. Again, the local change might be interpreted as part of a regional change.

Mitchell lists some changes as real, but these changes are still caused by local effects, not global effects. Foremost among real changes is the urban heat island effect. This effect is usually attributed solely to fuel combustion whose waste heat causes urban heating. As early as 1850 the frontier city of St. Louis had an urban heat island that occurred not from fuel combustion but from the exterior surfaces of buildings so constructed that they acted as light traps. Sunlight that is normally scattered back to space is instead multiply reflected from the buildings until it is absorbed. Many nearby buildings can act as absorbing cavities which lead to urban heat islands. Because of this effect, even small towns with no industry can be warmer than the surrounding country. Separating these spurious effects from other real climatic changes is very difficult. The urban heat island has contributed an estimated 0.1 °C increase in the average hemispheric warming of about 0.5 °C observed during the last century, creating a spurious warming trend.

Along with the difficulties in constructing a homogeneous temperature record at one site are complications that arise when averaging several stations together. Since stations are not uniformly spaced, they must be area weighted. Different weighting techniques can produce different reconstructions of regional temperature changes. The largest spatial scales create the most difficult problems when regions such as the oceans are not sampled or are poorly sam...
A Discussion of Plausible Solar Irradiance Variations, 1700–1992

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KENNETH H. SCHATTEL
NASA Goddard Space Flight Center, Greenbelt, Maryland

From satellite observations the solar total irradiance is known to vary. Sunspot blocking, facular emission, and network emission are three identified causes for the variations. In this paper we examine several different solar indices measured over the past century that are potential proxy measures for the Sun's irradiance. These indices are (1) the equatorial solar rotation rate, (2) the sunspot structure, the decay rate of individual sunspots, and the number of sunspots without umbras, and (3) the length and decay rate of the sunspot cycle. Each index can be used to develop a model for the Sun's total irradiance as seen at the Earth. Three solar indices allow the irradiance to be modeled back to the mid-1700s. The indices are (1) the length of the solar cycle, (2) the normalized decay rate of the solar cycle, and (3) the mean level of solar activity. All the indices are well correlated, and one possible explanation for their nearly simultaneous variations is changes in the Sun's convective energy transport. Although changes in the Sun's convective energy transport are outside the realm of normal stellar structure theory (e.g., mixing length theory), one can imagine variations arising from even the simplest view of sunspots as vertical tubes of magnetic flux, which would serve as rigid pillars affecting the energy flow patterns by entraining larger-scale eddies. A composite solar irradiance model, based upon these proxies, is compared to the northern hemisphere temperature departures for 1700–1992. Approximately 70% of the decadal variance in the last century can be modeled with these solar indices, although this analysis does not include anthropogenic or other variations which would affect the results. Over the entire three centuries, 50% of the variance is modeled. Both this analysis and previous similar analyses have correlations of model solar irradiances and measured Earth surface temperatures that are significant at better than the 95% confidence level. To understand our present climate variations, we must place the anthropogenic variations in the context of natural variability from solar, volcanic, oceanic, and other sources.

1. Introduction

In the past two centuries, many people have hypothesized that the solar irradiance at the top of the Earth's atmosphere varies. Recent satellite measurements confirm that such variations exist, at least on the timescale of the 11-year solar cycle [e.g., Willson and Hudson, 1991]. Most of the modeling undertaken to date, to understand these secular variations in the solar constant, have been phenomenological, utilizing proxies which enable the solar constant data to be fit (for example, Lean [1991] for a review). Although the models do not answer questions concerning the basic cause of secular solar constant variations, they do allow us to examine the photospheric manifestations of these variations. To date, most of the solar constant secular variations observed (which only includes a timescale on the order of a decade) have been associated with photospheric blemishes (dark sunspots, bright faculae, and bright network). At present, there seem to be very few attempts to understand potential secular trends. Phenomena in the Sun which could lead to irradiance variations on the timescale of decades to centuries were explored by Endal et al. [1985]. One view of active region physics [Schatten and Mayr, 1985, p. 1060] did suggest a positive correlation of solar constant with solar activity when they stated "Thus the (active region) process effectively transfers heat outward, aiding the Sun to shed its luminosity. If active regions have any effect on the solar luminosity, it should be a weak positive correlation." The view undertaken by these authors was that active regions are distinguished from the background photosphere by the influence of the magnetic field, which allowed a larger-scale flow pattern to develop (larger than granulation and supergranulation), and this pattern manifested itself in sunspots, where downflows were present, and faculae where upflows occurred. The zeroth-order effect was thought to be small as the two energies balance to zeroth order; however the first-order effect allowed heat (and energy) to be transferred outward. These effects were thought to be the origin of the positive correlation of solar activity with solar irradiance variations. Even if we can understand the solar cycle correlation with activity, these features may be merely "photospheric blemishes" and may not have a great influence on the longer timescale "river of solar luminosity" flowing outward from the Sun's interior, but rather primarily serve only to divert the flow and/or temporarily store and release minor amounts of this vast energy flow. The perturbations from active regions may not necessarily extend to the deep interior to influence very long timescale solar luminosity and solar constant variations. To understand the long-term secular variations, the Sun might need to be viewed on a larger, more global scale, with global observations (e.g., solar rotation, solar diameter, etc.).

On the timescale of decades to centuries, four classes of models exist which postulate different variations of the Sun's
output. These models can be called the "constant quiet Sun model," the "solar diameter model," the "activity envelope model," and the "umbra/penumbra variations model." The constant quiet Sun model postulates that the solar irradiance has only an 11-year cycle and all radiation changes can be explained by active features. Since all solar minima are the same in these models, it is called the constant quiet Sun model. Foukal and Lean (1990) and Schatten and Orosz [1990] present models of this type. The solar diameter model uses the solar diameter or its time rate of change as a proxy for solar irradiance variations. Some controversy still exists about the history of the solar diameter variations so this model will not be considered further here. The activity envelope model postulates that long-term solar irradiance variations follow the envelope of solar activity such as the Gleissberg cycle, so that solar minima irradiances vary over time (see, for example, Eddy [1978] or Reid [1991]). The umbra/penumbra (U/P) variations model is so called because early models of this class by Nardo [1955] and Hoyt [1979a] used sunspot structure expressed as the ratio of umbra to penumbral areas as a proxy measure of solar irradiance. Subsequent studies have used the solar equatorial rotation rate and the sunspot cycle length to derive very similar models. The U/P variations model and activity envelope model are similar except they are out of phase with each other with variations occurring ~20 years earlier in the U/P variations model. This paper presents evidence in support of the U/P variations model. We argue that the solar indices used in the U/P variations model are proxy indicators of long-term secular changes in convective energy transport.

Although changes in the Sun's convective energy transport are outside the realm of normal stellar structure theory (e.g., mixing length theory), one can imagine variations arising from even the smallest view of sunspots as vertical tubes of magnetic flux, which would serve as rigid pillars affecting the flow patterns by ensuring larger-scale eddies. Additional proxies for the U/P variations model are introduced here for the first time, namely the sunspot decay rate, the fraction of penumbral sunspots, the decay rate of the solar cycle, and the mean level of solar activity.

There is a variety of experimental evidence that indicates that there may be long-term irradiance variations which are not correlated with solar activity. For example, measurements of the last couple of decades have revealed trends in the equivalent widths of lines and the bisectors of lines. These observations can be interpreted as changes in the temperature gradient in the photosphere which says the convective energy transport is secularly changing in a manner not correlated with solar activity. These convective flux changes imply there may be an underlying secular change in irradiance in addition to the already identified 11-year cycle.

Evidence for changes in solar convective flux on longer timescales requires the use and interpretation of other solar proxies. In the past 13 years, several authors have postulated secular irradiance variations which are not correlated with solar activity. Hoyt [1979a, 1990], Gilliland [1982], Friis-Christensen and Lassen [1991], and others all independently arrived at the conclusion the Sun's irradiance increased from the late 1800s to a peak in the 1930s or 1940s. In the ideal case a full physical theory, starting from the basic equations for magnetohydrodynamics, could be developed to explain the observations of the above authors. Such a theory, however, is not yet available. Therefore, in section 2, plausible reasons for the relationship of solar sunspot decay rates, sunspot structure, solar cycle lengths, and other proxy indices will be developed. The basic approach is to show that many of these indices can be related mathematically to solar sunspot decay rates. Once a relationship to sunspot decay rates is developed, it is deduced that there are changes in convective velocities, convective energy transport, and hence solar irradiance. Five irradiance models will be combined to form a composite solar irradiance model for 1800-1992.

In section 3 we review various experiments to see if any independent data exist which would support the model of secular changes in solar irradiance. Because the model irradiance variations may be of interest to climatologists who are seeking explanations for climate change, section 4 is devoted to examining the temperature changes on the Earth which may be induced by the changes in solar output. In this regard, we will examine the issue of whether the Earth can be used as a radiometer, which requires that we pay attention to the stability of climate if the absence of external forcing. In the final section we will comment upon the uncertainties in our understanding of the Sun and climate and discuss directions for future research.

2. SECULAR IRRADIANCE VARIATIONS CAUSED BY CHANGES IN CONVECTIVE ENERGY TRANSPORT

Variations in the Sun's spectral irradiance \( S_\lambda \) can be written \( \text{[Gier et al., 1981]} \) as

\[
\Delta S(t) = S_\lambda(t) - S = \int_A \int_\lambda \Delta f_{\lambda}(\lambda, A, t) d\lambda \, dA
\]

where \( \lambda \) is the wavelength, \( A \) is a unit area on the solar disk, \( \Delta f_{\lambda} \) represents variations in the photospheric intensity, and \( t \) is time. Most solar irradiance variations are assumed to arise from active features on the Sun such as sunspots, faculae, and the active network. Equation (1) can be expanded in terms of solar limb darkening as follows:

\[
\Delta S(t) = \int_A \int_\lambda \left( a_\lambda(\lambda) + b_\lambda(\lambda) \mu + c_\lambda(\lambda) \mu^2 \right) C_{\text{act}} \, d\lambda \, dA
\]

where \( a_\lambda, b_\lambda, \) and \( c_\lambda \) are the limb darkening constants [e.g., Allen, 1978]. \( C_{\text{act}} \) is the relative contrast and equals zero in the absence of contrast features such as sunspots and faculae. Expressions for \( C_{\text{act}} \) are given by Schatten [1987] and will not be considered further in this paper. Instead, we are concerned with processes which could lead to changes in \( a_\lambda, b_\lambda, \) and \( c_\lambda \) and, in particular, are interested in proxy solar indices which would allow long-term secular changes in convective energy transport to be deduced.

A hypothetical change in convective energy transport manifests itself by variations in the solar limb darkening, the equivalent widths of lines, and the bisectors of lines. The diagnostic measurements are limited to the last two decades and discussed in more detail in section 3.2. It is desirable to search for parameters which provide similar information over decades and centuries. Several candidate parameters are available and will be examined here. Since convective rotation are strongly coupled in the lower convective
zone through the Coriolis force, an increase in convection may manifest itself by a change in solar rotation. The theory of solar rotation is not well developed but is discussed in section 2.1. The rate at which sunspots decay can plausibly be argued to be proportional to convective velocities. A change in sunspot decay rate would therefore be a plausible proxy for a change in convective energy transport and solar irradiance. Such changes can be shown mathematically to manifest themselves as changes in sunspot structure since penumbrae of sunspots are more readily destroyed than are their umbrae. In addition, the fraction of sunspots consisting of only penumbrae will also change as a result of a change in the sunspot decay rate. Section 2.2 discusses these three effects. An increased convective energy transport may cause more sunspots to appear because of the increased upward transport of magnetic flux tubes. This same increased convection may cause more rapid sunspot destruction and lead to more rapid decay of the envelope of solar activity and hence shorter solar cycles. Section 2.3 discusses these effects.

2.1. Changes in the Equatorial Solar Rotation Rate

Theoretically, a strong coupling between rotation and convection should exist (e.g., Rudiger, 1989), with rotation generally viewed as being driven by convection, so we start our discussion with a brief look at solar rotation. If a change in solar rotation is observed, a change in convective energy transport can be expected. Rudiger indicates it is safe to make the following three comments: (1) The interaction between convection and rotation is nonlinear; (2) the interactions are strongest in the lower portion of the convection zone; and (3) the rotation tends to occur in disk-shaped regions rather than cylinders. Can a change in solar rotation occur which is not accompanied by a change in convection? Any change in rotation is a persuasive indicator that the deeper levels of convection are varying and hence a variation in luminosity and irradiance is occurring.

Several authors have noted that changes in solar rotation rate occur. Because of the likely strong coupling between solar rotation and convection through the Coriolis force, these authors have argued that solar rotation can be used as a proxy measure of solar irradiance. Suzuki [1977] notes there was an increasing rate of equatorial solar rotation over solar cycles 18 to 20. Eddy et al. [1976] claim that the solar rotation rate during the Maunder minimum was 4% faster than modern values. Hoyt [1990] shows that equatorial solar rotation is high in the late 1800s and decreases to a minimum in the second quarter of the 1900s before increasing in recent years (see Figure 1).

2.2. Sunspot Structure and Sunspot Decay Rate Variations

Sunspots consist of a dark central region called the umbra which are nearly always surrounded by a less dark penumbra. The sum of the corrected umbra area (U) and the corrected penumbral area (P) gives the corrected average area (W) measured in millions of the solar hemisphere (MSH). The ratio of the umbra to whole spot area (U/W) or umbra to penumbral area (U/IP) may be a monitor of conditions in the Sun's convective zone. Previous work on this topic is given by Hoyt [1979a, b, 1990], Brown and Price [1984], and Nardo [1955]. In the following paragraphs we will show that changes in sunspot structure can be explained by changes in the rate of decay of sunspots. Because sunspot decay rates change over time, the fraction of sunspots consisting only of penumbrae (e.g., penumbral spots) also changes. Unlike sunspot structure for which measurements stop in 1977, the fraction of penumbral spots can be updated to 1989. This proxy index will be the one used in our solar irradiance models.

Moreno-Insertis and Vazquez [1988] have measured sunspot decay rates (Dv) using the Greenwich Observatory record for 1874–1959. They find that (1) the decay rate is linear in time for 95% of the sunspots, (2) it is independent of the maximum sunspot area, and (3) it is proportional to the perimeter of the spot. Their last conclusion suggests that some property of the photosphere is controlling the decay rate of sunspots. It appears as if the photosphere is dispersing magnetic elements of the sunspot into the surrounding photosphere. Meyer et al.'s [1974] dispersal theory for sunspot decay has a decay rate proportional to a mean convective velocity. This suggests the convective velocities and convective energy fluxes are secularly changing. Alternative theories based upon subtraction of sunspots or reconnection of magnetic fields also have decay rates proportional to convective velocities. Because of the complexity of the decay process, it is not yet possible to relate quantitatively a change in sunspot decay rate with a change in the convective velocity spectrum and hence with solar irradiance.

Moreno-Insertis and Vazquez (abbreviated M-V in the next few paragraphs) find that the decay rate has extreme variations of as much as 25% over several cycles. For solar cycle 13 (1890–1901), complex groups decayed linearly at the slow rate of 36 ± 2 millions of the solar hemisphere per day (MSH/day). For cycle 16 (1913–1933) the fast decay rate was 44 ± 2 MSH/day. For isolated sunspots the decay rate varied from 16 to 20 MSH/day for these two cycles. For both types of groups, the mean variation is from 26 to 32 MSH/day. The decay rates vary over a range of ~25%. For these two cycles, umbrae in complex groups decayed at a mean rate of 8.3 ± 0.5 MSH/day, but for isolated sunspots, it is 3.9 ± 0.4 MSH/day. In Figure 2 we illustrate the measured decay of sunspots in cycles 13 and 16.

If, in each cycle, one starts with identical sunspots with
to support this conclusion since 4 out of 5 cycles have umbra decay rates within one standard deviation of each other; both isolated sunspots and for complex groups. A tilt variation in umbra decay rates would complicate, but not invalidate, our modeling since it can either improve or degrade the match between model and measurements.

\[ \frac{U}{W} = \frac{\sum_{i=1}^{N} U_i}{\sum_{i=1}^{N} (U_i - D_{\text{umbra}})} \]

where \( t \) is the time in days and one measurement per day made, \( U_i \) and \( W_i \) are the initial umbra and spot sizes. Cycles 13 and 16 for isolated sunspots, (3) gives a mean \( \bar{U} \) values of 0.154 and 0.185 compared to the numerical simulations of 0.150 and 0.183. Not only can secular sunspot structure variations be explained by secular variations in the decay rate of sunspots, but the process can be reversed to derive sunspot decay rates from the more extensive sunspot structure measurements. Using the approximate daily mean properties for sunspots for the last century bas

Fig. 2. Moreno-Insertis and Vazquez's [1988] measured sunspot decay rates for cycle 13 in the 1990s (upper curve) and for cycle 16 in the 1930s (lower curve) are illustrated. The black areas are umbrae, and the black areas are penumbrae. Note that more penumbral umbrae are predicted for cycle 13 than for cycle 16.

The growth phase of sunspots is neglected in the above analysis. Since sunspots grow rapidly and decay slowly, most of their life is spent in the growth phase. This helps minimize the contribution of the growth phase to the measured \( \frac{U}{W} \) values and is another contributor to the successful agreement in the last paragraph.

3. The simulations assume the umbra decay rates are constant from cycle to cycle. M-V's umbra decay rates tend
upon Allen's tables and M-s observations (i.e., \( D_{\text{umbra}} = 6.6 \times 0.4 \text{ MSH/d} \), \( U_W = 138 \text{ MSH} \), \( W_0 = 728 \text{ MSH} \), and \( N \) days), the sunspot decay rate in MSH/day can be expressed as

\[
D_{\text{spot}} = \frac{63.3 - (6.0 \pm 0.4)}{U/W} \tag{4}
\]

This equation gives a mean value of \( D_{\text{spot}} \) over the previous century of 28.8 MSH/day. Derived values of \( D_{\text{spot}} \) are plotted in Figure 4 for those active years when the annual mean umbra areas exceed 100 MSH. The derived values of \( D_{\text{spot}} \) range from \(-15\) to 34 MSH/d and follow the same temporal form as the measured values, also shown in Figure 4.

A change in the rate of sunspot decay has additional consequences, which are apparent in Figure 2. Near the end of the life of a sunspot, it often appears only as a penumbral spot, the umbra having already vanished. For slowly decaying sunspots the penumbral spots last longer than for rapidly decaying sunspots. Penumbral spots are more stable and common when sunspot decay rates are low. Therefore the fraction of sunspots consisting of only penumbrae should vary as a function of time. Figure 5 shows the time variation of the fraction of penumbral spots plotted inversely and overlaid on the sunspot structure values. Both curves are similar. Sunspot structure shows several discontinuities in the early years that almost vanish in the fraction of penumbral spot curve. Using the Rome Observatory measurements, this curve can be extended to 1989, while the \( U/W \) measurements stop in 1977. Thus the fraction of penumbral spots will be used in our irradiance reconstruction. Sunspot structure values are heavily influenced by the large sunspots, but the fraction of penumbral sunspots is dominated by the smaller sunspots. The two measurements are nearly independent. The self-consistency between the measured sunspot decay rates, sunspot structure, and fraction of penumbral spots increases one's confidence that the measured secular variations are generally reliable.

2.3. Solar Cycle Length and Sunspot and Cycle Decay Rate Variations

Fris-Christensen and Lassen [1991] have recently argued that changes in the smoothed solar cycle length \( L \) may provide a measure of the Sun's irradiance. A correlation between the Earth's temperature and solar cycle length exists which Fris-Christensen and Lassen attribute to variations in the Sun's output. Using arguments based upon rocket and balloon measurements of the solar irradiance in the late 1960s and early 1970s, they estimate that the peak-to-peak amplitude variation over the past century in solar irradiance is 1%. Fris-Christensen and Lassen used a 1-2-1 filter to smooth the cycle lengths. We used a differentiating technique. Each year has a level of activity which may be expressed as a percent of the maximum level of activity for the cycle it belongs to. For each year one may find the cycle lengths by measuring the elapsed time between equal percentage levels of activity. Two cycle length determinations are made each year in this approach, so nearly all the data are used rather than selected extremum points in the cycle. A 23-year running mean was then applied to obtain the final results. These values, along with Fris-Christensen and Lassen's values, are shown in Figure 6. In this section we examine these cycle length variations and relate them to changes in the decay rate of individual sunspots, the decay rate of sunspot cycles, and the mean level of solar activity. Earlier work relating variations in solar cycle length to climatic variations is given by Clough [1905, 1933, 1943] and Muller [1926].

The sunspot cycle length in months \( L_{\text{cycle}} \) can be linearly fit in terms of the mean sunspot decay rate \( D_{\text{spot}} \) for cycles 12 to 16 as follows:

![Fraction of Penumbral Spots and Sunspot Structure](chart.png)
Fig. 6. Solar cycle lengths based upon a 1:2:1 filter technique using solar maxima (dashed line) and upon a differencing technique followed by a 23-year smoothing. The differencing method uses all the years of data rather than just the years of maxima and/or minima.

\[ L_{\text{max}} = (251.1 \pm 5.4) - (3.98 \pm 1.02)D_{\text{spot}} \] (5)

Cycle lengths and sunspot decay rates have 84% of their variance in common. Using this equation and M-V's unweighted mean spot decay rate of 30 MSH/d, \( L_{\text{max}} \approx 131.7 \) months or 10.98 years. If we use Stewart and Panasyshky's [1938] measurements of cycle properties and Gleissberg's [1949] cycle model, cycle length and sunspot decay rate are related by the following equation:

\[ L_{\text{spot}} = (246.5 \pm 0.7) - (4.73 \pm 0.07)D_{\text{spot}} \] (6)

The differences between these two results can be explained, in part, by noting that (6) is based upon sunspots of all types and (5) is based upon the mean of isolated and complex sunspots. From (6) a mean cycle length of 10.7 years for the twentieth century gives a mean sunspot decay rate of 24.9 MSH/d. This seemingly slow decay rate, compared to M-V's results, simply tells us that the average sunspot is more like an isolated sunspot than it is like a complex group. Since minimum to maximum cycle lengths have varied from \(-9.9\) to \(-12.1\) years over the last century, (6) implies sunspot decay rates have varied from \(-21.6\) to \(-26.8\) MSH/d.

Using Gleissberg's sunspot cycle model and Monte Carlo techniques, the solar cycle can be simulated as a function of sunspot decay rates. In any one solar cycle, many sunspots are being generated more or less randomly in time followed by their destruction, 95% of which exhibit a linear decay. The sum of the areas of individual sunspots \( A_{\text{total}} \) generated at time \( t_{0,j} \) and decaying with an average rate \( D_{\text{spot}} \) can be expressed as follows:

\[ A_{\text{total}}(t) = \sum_{j}^{N} \sum_{i}^{T_j} [A_{0,j} - D_{\text{spot}}(t_{i,j} - t_{0,j})] \] (7)

where \( j \) is the number for each sunspot for \( N \) total spots, \( A_{0,j} \) is the initial spot area at time \( t_{0,j} \), and \( t_{i,j} \) is the time since \( t_{0,j} \) for the \( j \)th sunspot. The rate of decay of the total spot area is proportional to mean rate of decay of individual sunspots. Using (7) and Gleissberg's model to simulate the probability for sunspot generation, a Monte Carlo simulation

Solar cycle lengths can be split into a rise time minimum to sunspot maximum and a decay off from the maximum to the next minimum. Cycle lengths vary mainly because of changes in the length of the decay time while the rise times are much more nearly constant at \( 4.30 \pm 1.10 \) years based upon cycles 1 to 21.

\[ D_{\text{spot}} = -3.93 \pm 1.58 \] (7)

Hence the change in downward slope can be used as an proxy to monitor long-term secular changes in the sunspot generation. An example of how normalized sunspot cycles appear is given in Figure 7. The decay rate of sunspots is related to normalized cycle decay rate by following regression equation:

\[ D_{\text{spot}} = -3.93 \pm 1.58 \] (7)

\[ (dR_{/dt})_{\text{max}} / R_{\text{max}} \]

Effect of Changes in Sunspot Decay Rate with Identical Sunspot Generation

Fig. 7. A Monte Carlo simulation of sunspot cycles with sunspots decay slowly (22 MSH/d) or rapidly (28 MSH/d). The length of generation of sunspots at solar maximum are set equal for the cycles, but the results are not significantly affected by changing rates of sunspot generation. The mean of 30 simulations are shown. Both the length of the cycle and the decay rate the cycle change as functions of individual sunspot decay rates.
where \( R_{12, \max} \) is the smoothed sunspot maximum published by Hoyt [1991] used to normalize the sunspot decay rate to a decay rate per group, and \((dR_1/dt)_{\max}\) is absolute value of the mean cycle decay rate per year averaged over 5 years. The constant 192.3 is simply a conversion factor and theoretically is expected to be 365.2 or 182.5. The measured individual sunspot decay rates and the normalized cycle decay rates have 86% of their variance in common. The maximum and minimum decay rates derived from (8) are 31.3 \pm 0.3 and 23.9 \pm 2.9 MSHd respectively. These results indicate a peak value between 1920 and 1931, or a few years earlier than other irradiance proxies, and indicate that recently the irradiance may have leveled off at a value higher than it was at the turn of the century.

Previous authors have noted that the length of solar cycles may have a frequency modulation. For example, Granger [1957] points out that the solar cycle length is not a constant over time and a frequency modulation is probable. He indicates that the solar cycle length in months measured from minimum to minimum (\( L_{\text{mon}} \)) is not an independent variable but is a function of the mean Wolf sunspot number for the cycle (\( R_z \)). An equation relating these two indices is

\[
L_{\text{mon}} = \frac{12}{0.074086 + 0.000347R_z}
\]

Approximately 66% of the cycle length variance can be explained by (9). In effect, the mean level of activity for each cycle can be used to derive a model for cycle lengths. Thus the mean level of solar activity can be used to derive a solar irradiance model, if one grants that the mean level of solar activity is a following indicator of changes in solar convection. Dicke [1979] and Brown and Price [1984] point out that magnetic flux tubes may take many years to rise from the base in the convection zone to the photosphere. In this study we take the delay time to be 11 years to place this index in phase with the other indices. Dicke suggested 13 years as the time for flux tubes to rise from the base of the convection zone to the photosphere.

If the above discussion about cycle lengths and sunspot decay rates is correct, some unusual cycle lengths and decay rates would be expected during the Maunder Minimum in the late 1700s. At this time, the Wolf sunspot number was near zero for many years. Using (9) above and setting \( R_z \) to zero, one anticipates cycle lengths would average \(-13.5\) years. From examination of Kacharov's [1987] carbon 14 observations, it appears there were five solar maxima at around 1646, 1660, 1674, 1692, and 1705 compared to the usually accepted sequence of six maxima at 1649, 1660, 1675, 1685, 1693, and 1705. With five solar maxima, one obtains an average length of 14.75 years from 1646 to 1705. During the Dalton Minimum around 1800, two solar cycles lasted 14 years each [Hoyt and Schatten, 1992]. If convection was weak in the Maunder Minimum, then it follows that sunspots lived longer on average than present-day sunspots. Using (5) and (6), the sunspot decay can be estimated to be \(-16.6\) MSHd in the late 1600s. Observational evidence for slow sunspot decay rates comes from Sporer [1889] where 2 out of 2 sunspots observed from 1672 to 1700 lasted for four solar rotations. In the past century, one finds \(-1\) out of 769 sunspots survive through four solar rotations [e.g., Allen, 1976]. The probability of seeing two long-lived sunspots out of a sample of 23 spots is \(1\) in \(-1100\) if the Sun is same in the Maunder Minimum as it is now. The observations suggest that the Sun was indeed different in the late 1600s.

In summary, there are reasons to think that changes in solar cycle length and the normalized decay rate of solar activity reflect changes in solar convective strength and hence in solar irradiance. Cycle lengths, the normalized cycle decay rate, and the mean level of solar activity allow models of solar irradiance to be extended back to the mid-1700s. All three models share many similarities. If further research finds that solar cycles lasted \(-14\) years during the Maunder Minimum, this would provide more support for changes in solar irradiance and would allow the models to be extended back to the 1600s.

2.4. A Composite Model for Irradiance Variations

In each of the above sections we have discussed how a change in convective energy transport may manifest itself by changes in five solar indices: (1) the fraction of penumbral spots, (2) solar cycle length, (3) equatorial rotation rate, (4) decay rate of the solar cycle, and (5) mean level of solar activity.

All the solar indices which we are proposing as solar irradiance proxies rise from a minimum around 1880 to a maximum in the 1930s. These extremes represent the peak-to-peak irradiance variation for the last century which can have only one value. There are several approaches that could be taken to derive the amplitude of the variations. In an earlier study of this problem by Hoyt [1999a], a peak-to-peak amplitude of 0.38% was deduced based upon sunspot structure, sunspot decay, and the mixing length theory for convection. Using the Nimbus 7 observations and Spencer and Chtriry's [1990] temperature record for 1979 to 1990, the Earth climate sensitivity can be estimated as 1.67 °K change for each 1°C change in the solar irradiance. For the 0.5 °K rise in temperature from 1880 to 1940 a 0.30% peak-to-peak sensitivity is implied. A 0.30% amplitude also gives the best correlation with climate. Nonetheless, both these numbers seem high, since such a large upward trend would probably manifest itself in the satellite measurements. Lean et al. [1992] estimate that the Maunder Minimum may have had an irradiance \(-2.7\) W/m² lower than the 1986 minimum, but Nesmes-Ribes and Mangeneu [1992] estimate a decrease of 0.5% or 6.8 W/m². If the Dalton minimum and the Maunder minimum both had cycle lengths of \(-14\) years and therefore similar levels of irradiance, a peak-to-peak variation over the last century of 0.14% to 0.25% is found. The value 0.14% is used in this paper since it is based solely on known solar properties, so no recourse to a climate response needs to be invoked. On the basis of our present understanding of the sensitivity of the Earth to fluctuations in solar irradiance, there are no known mechanisms that allow such a low amplitude of variation to explain the observed climate fluctuations.

The five models are illustrated in Figure 8. The fraction of penumbral spots model has more year to year variability than the other models and is probably picking up real solar variations which the other models cannot resolve. The solar rotation model has two peaks which arises, in part, from the difficulty of obtaining a good measure of solar rotation with the few observations available. Each model is taken to be a different and somewhat imperfect measurement of an underlying "true" variations. There is relatively good phase...
Five Solar Irradiance Models

![Graph showing solar irradiance models]

Fig. 8. Five irradiance models are scaled so that they each have a peak-to-peak amplitude of 0.14% over the last century. Despite some differences, all the models are similar in deducing lower solar irradiiances in the 1800s, high values in the 1930s, and lower values after the 1930s. Changes in the solar rotation rate is a strong indication that changes in convective energy transport are occurring deep within the convection zone.

agreement between the solar indices, as summarized by Table 1. The solar rotation appears to be ~11 years out of phase with the other indices. Perhaps solar rotation is responding to convection near the base of the convection zone while the other indices are responding to convection changes near the top of the convection zone. To approximate an 11-year solar activity component which includes contributions from facular emission and sunspot blocking, we use the measurements of the Wolf sunspot number and the Nimbus 7 solar irradiances for 1976–1992 [Hoyt et al., 1992]. During this period the annual mean Wolf number ($R_{\text{w}}$) has varied from ~0 to 150 and the solar irradiances ($\Delta S$) have varied by ~1.5 W/m$^2$. Thus the activity component of the solar irradiances can be approximated as

$$\Delta S_{\text{activity}} = 0.01R_{\text{w}}$$

A composite solar irradiance model based upon five solar indices plus an added activity component is shown in Figure 9. The one standard deviation uncertainty provides a measure of the agreement among the different techniques used to derive the irradiance variations. For 1700–1874, three indices exist for solar irradiance reconstruction, namely cycle length, cycle decay rate, and mean level of solar activity. For 1875–1978, up to five solar indices are used, namely the three just mentioned plus solar rotation and the fraction of penumbral sunspots. Two solar indices (sunspot structure and the time rate of change of the solar diameter) give similar time variations, but because of uncertainties in their values are not used here. For 1979–1992 the irradiances are scaled to the mean of the Nimbus 7 measurements. In the composite model, adjacent solar minima may differ by only a few hundredths of a percent and would be difficult to detect experimentally, a subject to which we now turn.

3. Experimental Evidence for Irradiance or Convection Changes

Is there any direct observational evidence to support a hypothesis that the Sun has long-term variations in irradiance like the composite model? In this section we examine two groups of experimental evidence which bear on the question. The first line of evidence is based directly upon radiometric measurements of solar irradiance either from satellites or the ground. The second line of evidence concerns further indirect measures of solar irradiance or diagnostic measurements of the photosphere that may indicate changes in solar convection or irradiance. These two groups of experimental evidence are split into two subsections.

3.1. Direct Radiometric Evidence

If the hypothesis of secular solar irradiance variations is true, it might be detectable in the satellite observations made by Wilson and Hudson [1988, 1991] using the active cavity radiometer (ACRIM) on the Solar Maximum Mission (SMM). Wilson and Hudson [1991] point out the SM ACRIM measurements in early 1980 diverge from the solar irradiance models based upon variations caused by facular emission, active network emission, and sunspot blocking. The difference noted by Wilson and Hudson may be indication of another source of solar irradiance variations. The Nimbus 7 measurements support the SMM/ACRIM measurements in indicating a modeling, as opposed to measurement problem, exists in 1980.

When activity is low or zero, a long-term trend in irradiance might reveal itself. Since the Nimbus 7 measurements are noisy during the solar minimum, we examined

TABLE 1. Phase Relationship of the Solar Indices

<table>
<thead>
<tr>
<th>Index/Year(s) of 20th Century Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunspot structure (URY)</td>
</tr>
<tr>
<td>Fraction of sunspots with umbras</td>
</tr>
<tr>
<td>Rates of sunspot decay</td>
</tr>
<tr>
<td>Solar cycle lengths (1-2-1 filter)</td>
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<tr>
<td>Solar cycle lengths (this study)</td>
</tr>
<tr>
<td>Normalized rate of solar cycle decay</td>
</tr>
<tr>
<td>Equatorial solar rotation</td>
</tr>
</tbody>
</table>

![Graph showing combined solar irradiance]

Fig. 9. A plot showing the combined solar irradiance using the models in Figure 8 and adding a solar activity component. The error bars show the relative disagreement among the different techniques used to derive the irradiance variations. For 1700–1874 models based upon cycle length, cycle decay rate, and mean level of solar activity are used. For 1875–1992, up to five solar indices are used.
of the SMM/ACRIM data from 1985 to 1987. Days with sunspot blocking, based upon the photometric sunspot index (PSI) of Wilson and Hudson [1991], are discarded yielding 271 quiet days. The quiet days are not all alike, but vary by several tenths of a watt per square meter. The scatter is caused by variations in the number of faculae present on quiet days and to a lesser extent by the continuing presence of small unresolved sunspots. Quiet days occurring just before a sunspot appears or just after a sunspot disappears are brighter than other quiet days. Starting early in 1987 some of the quiet days are influenced by very small sunspots since the daily standard deviations of the ACRIM measurements become larger. Sorting the quiet days into 6-month groups and averaging reveals a small upward trend from mid-1985 through 1986. This trend is not statistically significant and because of residual faculae does not allow the presence of a background trend to be resolved. The composite model predicts that a zero slope for irradiance must occur at each solar minimum which can only be shortened or lengthened by the any underlying trend. Self-consistent measurements of two or more solar minima, sufficient to detect differences at the level of a few hundredths of a percent, are required if radiometric observations are to detect the postulated changes.

Abbot at the Smithsonian Astrophysical Observatory (APO) made extensive ground-based measurements of the extraterrestrial solar irradiance from 1923 to 1954 [e.g., Hoyt, 1979c]. These measurements suffer from errors primarily arising from the inability to remove all atmospheric influences. For example, the Chilean volcanic eruptions in 1983 depressed the APO solar constant values to their lowest values. Therefore the APO observations are not of sufficient precision to resolve the validity of the sunspot structure hypothesis. Pettit [1932] made many observations of the solar ultraviolet flux in the late 1920s. He finds high values of solar ultraviolet measurements at 0.32 µm occur when solar activity is high. However, his active Sun ultraviolet irradiances exceed his quiet Sun values by ~50%. Modern observations and theory [e.g., Lean, 1991] suggest variations at this wavelength are <1%. Pettit's observations must have some flaw arising from instrumental problems or from data reduction errors.

In summary, the radiometric measurements do not as yet provide any evidence for a long-term secular variation in solar irradiance except for the discrepancy between the models and satellite measurements in 1980. This lack of evidence is perhaps no surprise since the predicted effect is at or beyond past, and perhaps future, capabilities.

3.2. Indirect Measures of Solar Irradiance

and Diagnostic Measurements

If there is some change in the convective energy transport with time, there will be a change in the temperature gradient in the photosphere. A temperature gradient change will cause $b_2$ and $c_p$ (in equation (2)) to vary. The coefficient $a_p$ will change if there is a global increase in the effective temperature of the Sun. Changes in limb darkening are probably subtle and difficult to detect and may appear as wavelength variations. Kuhn et al. [1988] have examined the changes in solar limb brightness from 1983 to 1987 and claim that a portion of the variations are explained by faculae, but another part of the variations are explained by changes in the effective temperature of the photosphere. Kroll et al. [1990] have measured changes in solar limb darkening which they postulate may be caused by changes in convective energy transport. Kroll et al.'s limb darkening variations appear to have a component that is not well correlated with solar activity changes.

Additional experimental evidence for changes in convective energy transport comes from the examination of the width of the carbon line at 5380 Å [Livingston, 1990; Livingston and Holweger, 1982]. This line is formed relatively deep in the photosphere and shows a monotonic increase in width from 1978 to 1990. Coupled with measured variations of equivalent widths of other lines formed at different depths in the photosphere, the temperature gradient apparently is changing secularly, implying a secular change in the convective energy transport, with changes in $b_2$ and $c_p$ causing a solar irradiance change. Theoretical models cannot, as yet, provide a quantitative estimate of the solar irradiance variations arising from this effect. It does suggest that the solar limb darkening is changing secularly and that a component of solar irradiance variations exists which is independent of the level of solar activity.

Yet another indication of changes in the convective energy transport in the photosphere comes from measurements of the bisectors of Fraunhofer lines [Livingston, 1982]. These measurements show that the asymmetry of the iron line at 5250 Å changed between 1976–1977 and 1980–1981. The change can be explained by a change in the velocity of solar convection, but a theory relating these changes to an irradiance change is not yet developed.

Finally, Schatten [1979] shows there are secular changes in the brightness of the great red spot on Jupiter. Internally self-consistent Jovian observations cover the period from 1892 to 1948 and show the red spot was brightest around 1928. The spot brightness has a 0.63 correlation with the composite irradiance model compared to a 0.37 correlation with Wolf sunspot number. Schatten attributes the spot brightness variations to changes in the solar ultraviolet radiation. These observations are consistent with the existence of a long-term secular solar irradiance variations.

The indirect measures seem to provide more support for a secular change in solar irradiance than do the direct measurements. The theories for solar convection, however, are as yet not sufficiently developed to convert these indirect measures into a quantitative value for the change in solar irradiance. They do indicate changes in solar convection may be occurring which are independent of solar activity.

4. The Climate Connection

If the solar irradiance is varying as postulated in the above discussion, it can be expected to have some effect on the temperature of the Earth. In this section we empirically examine the two questions: (1) is the Earth responding in a manner consistent with an external forcing and (2) do the Earth's temperature variations and the model solar irradiance variations correlate with each other?

A solar forcing will cause the two hemispheres of the Earth to vary in parallel. The amplitudes of the responses will differ because the two hemispheres have different amounts and distributions of land and ocean. To check for evidence for an external forcing, we first separately detrend the northern and southern hemisphere temperature records
of Hansen and Lebedeff [1987] using the slope of a linear regression fit through the hemispheric mean temperatures. This upward trend in temperature over the last century can be attributed to a greenhouse warming, an urban heat island effect [e.g., Karl and Jones, 1989], changes in the distribution and number of sampling stations [Willmott et al., 1991], changes in the diurnal temperature sampling [Edwards, 1987], changes in shelter construction, thermometer type, or local exposure [Mitchell, 1952], and other effects. Removing the trends in temperature reduces the influence of these extraneous effects. For 1880–1990 the detrended temperature variations of the two hemispheres have a correlation coefficient of 0.55. The nondetrended temperature variations have a 0.80 correlation. Both correlations are significant at the 99.9% confidence level or better indicating that it is highly probable an external forcing is being imposed. A random walk type of climatic change would not be expected to produce a positive correlation between the two hemispheres.

Further evidence for the external forcing of climate changes comes from the study of Ardanuy et al. [1992]. Using the Nimbus 7 Earth Radiation Budget (ERB) and THRS/TOMS data sets, they show that the Earth’s temperature is stable in the sense that any variation is forced back toward an equilibrium set point. The Earth therefore behaves like a thermostat with a fixed set point. Any long-term drift away from the set point is therefore unlikely. The set point can be altered by changing its value through a change in the composition of the atmosphere (e.g., the greenhouse effect) or by an external forcing (e.g., changes in surface albedo or changes in solar irradiance).

The combined model for solar irradiance seen at the Earth (Figure 9) extends over ~250 years so it would be useful to compare it to a hemispheric or global model for climate variations over this time. Groveman and Landsberg [1979a, b] and Landsberg [1981] provide the only published reconstruction of the temperature of the northern hemisphere from 1579 to 1880. Their temperature anomalies can be extended to the present by using Hansen and Lebedeff’s temperature anomalies. All other published reconstructions of climate over this timescale are local reconstructions. With fewer thermometer observations available as one goes back in time, the uncertainties in Groveman’s estimations of temperature become larger.

The combined solar irradiance model is correlated with the temperatures of the northern hemisphere of the Bar (Figure 10). On a decadal timescale the solar irradiance model can explain ~71% of the variance during the past 100 years and ~50% of the variance since 1700. The model and measured temperatures share many similarities, but several differences are worth commenting on. The irradiance model predicts the mid to late 1700s were warmer than Groveman and Landsberg deduce. Briffa et al. [1995] however, indicate that 1748–1767 was the warmest 20-year group of summers in the last two centuries and 1761 was the warmest summer in Scandinavia. Groveman and Landsberg’s temperature reconstruction uses thermometer measurements primarily from Europe, so there may be a problem in the temperature reconstruction. Another difference occurs for the 1830s, when Groveman and Landsberg temperatures show a much sharper peak than the irradiance model. Finally, around 1850 the model irradiances a temperature go in opposite directions. Smyth [18] claimed the Sun was getting brighter at this time, which is the opposite of our model results. Clearly more work reconstructing both the solar irradiance and the temperature variations is required. Statistically, the temperature variations are consistent with a solar forcing, although physics: the amplitude of the solar variations imply the Earth would be more sensitive to solar forcing than is generally believed as mentioned in section 2.4.

5. SUMMARY AND DISCUSSION

There is plausible evidence for long-term changes in solar irradiance. Over the last two decades, diagnostic measurements of the equivalent width of lines, the limb darkening of the Sun, and line bisectors all indicate secular changes in solar convection, the photospheric temperature gradient, and solar irradiance are possible. Additional evidence long-term irradiance changes come from such proxy measures as sunspot structure, sunspot decay rates, the length of solar cycles, the normalized solar cycle decay rate, equatorial solar rotation rate, and the time rate of change of the solar diameter. The variations in these indices plausibly be explained as arising from a common source namely secular changes in solar convective energy transport or convective velocities. We recognize that such changes outside the domain of usual theories of stellar structure. If all the observed solar variations do so too. Without consideration of the arguments put forth in this paper seems more plausible for all these solar proxies to play a role in the varying solar irradiance than it would be for these variations to exist with an invariant solar brightness.

For all the proxy models considered the solar output varies by less than about ±0.2% in the last century solar convection zone stores approximately 10^46 ergs perturbation in radiative flux of 0.2% lasting for one century amounts to 1 part in 40,000 of the total thermal energy in the convection zone. For comparison, the thermal energy storage in the Earth’s atmosphere has varied by ~1 part 500 over the last century. Energetically, there seems reason to rule out these irradiance variations. The longer
timescale of the variations, the deeper the likely source for the perturbation will be. Relatively short variations from sunspots and faculae, lasting days, are the result of perturbations in the top few thousand kilometers below the photosphere. The root source of the longer variations may arise from deep within the convection zone, perhaps at its base or just below its base, because of the observed solar rotation changes. Endal et al. [1985] and Nesme-Ribes and Mange-


Brown, G. M., and I. T. Price, Solar control of terrestrial tempera-


Endal, A. S., S. Soffia, and L. W. Twigg, Changes of solar luminos-


Grove, B. S., and H. E. Landsberg, Simulated northern hemi-


Kuhn, J. R., K. G. Liebrecht, and R. H. Dekke, The surface


Global Atmospheric Temperature Monitoring with Satellite Microwave Measurements: Method and Results 1979–84

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(Manuscript received 21 October 1989, in final form 4 May 1990)

ABSTRACT

A method for measuring global atmospheric temperature anomalies to a high level of precision from satellites is demonstrated. Global data from the Microwave Sounding Units (MSUs), flying on NOAA satellites since late 1978, have been analyzed to determine the extent to which these data can reveal atmospheric temperature anomalies on both short and long time scales for regional and larger space scales. The global sampling provided by the MSUs is an important asset, with most of the earth sampled biweekly from each of (typically) two instruments flying concurrently on separate satellites at different solar times. The primary source of tropospheric thermal information is from the MSU 53.74 GHz channel. This channel is primarily sensitive to thermal emission from molecular oxygen in the middle troposphere, with relatively little sensitivity to water vapor, the earth’s surface, and cloud (especially cirrus) variations. The long-term stability of the oxygen mixing ratio in the atmosphere makes it an ideal tracer for climate monitoring purposes. Lower atmospheric temperature anomalies are derived from the MSU 57.91 GHz channel.

Comparisons between monthly MSU temperature anomalies and corresponding thermometer-measured anomalies for the United States reveal a high (0.9) correlation, but hemispheric anomalies show much lower correlations. This results from some combination of poor thermometer sampling of remote regions and weak coupling of surface and deep-tropospheric temperature anomalies in tropical areas.

Analysis of data from two of the MSUs (NOAA-6 and NOAA-7), whose operational periods overlapped by two years, reveals that hemispheric temperature anomalies measured by the separate instruments are very similar (to about 0.01°C) on monthly time scales. Their combined time series of unfiltered two-day hemispheric averages show standard deviations of their mean of 0.15°–0.2°C and standard deviations of their average difference of 0.07°–0.03°C, indicating a signal-to-noise ratio of 20 for the Southern Hemisphere and 45 for the Northern Hemisphere. The intercomparison period also reveals no evidence of calibration drift between satellites at the 0.01°C level. This was substantiated by two 15-month comparisons of NOAA-6 with radiosonde data from 45 stations in the eastern United States, which revealed 0.03°C set difference over five years. Monthly averaged comparisons between individual radiosonde and NOAA-6 data from 1980 through 1982 reveal a monthly standard deviation of their difference of 0.04°C. The statistical and geophysical portions of this noise are found to be about equal in magnitude, 0.03°C. The single-satellite noise due to imperfect sampling for ten-day, 2.5° gridpoint temperatures was calculated by measuring the standard deviation of the difference between two satellites with ranges from 0.2°C in the tropics to 0.4°C in middle latitudes.

The period of analysis (1979–84) reveals that Northern and Southern hemispheric tropospheric temperature anomalies (from the six-year mean) are positively correlated on multidecadal time scales but negatively correlated on shorter time scales. The 1983 ENSO dominates the record, with early 1983 unusually averaged tropical temperatures up to 0.6°C warmer than the average of the remaining years. These natural variations are much larger than that expected of greenhouse enhancements, and so it is likely that a considerably longer period of satellite record must accumulate for any longer-term trends to be revealed.

The problem

Changes in the global climate system have received a high level of scientific, political, and public visibility in the last several years. The possibilities of rising ocean levels and significant regional changes in climate due to anthropogenic greenhouse enhancements have received widespread attention. Unfortunately, the potentially inadequate geographical distribution of thermometers has resulted in much uncertainty (and thus controversy) about whether temperature anomalies on a hemispheric basis can even be confidently inferred from conventional data. Sparser populated regions are...
either poorly measured or not measured at all. Changes in thermometer exposure due to urbanization are known to result in apparent warming of well populated locations (Karl et al. 1988; Balling and Idso 1989). Unfortunately, correction for this urbanization effect is difficult since the majority of land station locations have likely experienced some sort of local increase in exposure to man-made structures. Of course, most oceanic areas go unmeasured. Thus, we are faced with the task of understanding what portion of climate change is to be attributed to man versus "natural" variations, when we cannot even quantify with confidence what the background natural variability is.

b. Satellites to monitor climate?

In contrast to conventional measurements, satellites can provide the global coverage that is needed to monitor the earth's atmosphere. Unfortunately, the issue of satellite instrument calibration has typically been a source of great concern and uncertainty. However, possibly the best calibrated instruments in earth orbit to date have direct application to the global atmospheric temperature monitoring issue. These are the Microwave Sounding Units (MSUs), built by the Jet Propulsion Laboratory (JPL) for the National Oceanographic and Atmospheric Administration’s (NOAA) operational weather monitoring needs. Because these instruments measure a vertically averaged atmospheric temperature, we feel that they have the potential for significantly augmenting the surface-based thermometer record by providing a measurement representing a significant depth of the troposphere, rather than just a thin near-surface layer sensitive to variable surface effects (urbanization, desertification, etc.). This paper provides detailed technical aspects of the MSUs utility as a climate monitoring device. A related paper (Spencer and Christy 1990) summarizes the global temperature anomalies observed during 1979–88.

c. Theory

The MSUs are designed to measure the thermal emission by molecular oxygen in the atmosphere at different spectral intervals in the National absorption complex near 60 GHz (Meeks and Lilley 1963). Because the oxygen abundance in the atmosphere is very stable in both space and time (Warnke 1988) it makes an ideal tracer for radiometric atmospheric temperature monitoring. As Macht and Hughes (1970) state, "all reliable oxygen data since 1910 fall in the range of 20.94%-20.95% by volume," with the instrumental accuracy of in situ measurements being ±0.006% by volume. In contrast, infrared temperature monitoring methods depend upon thermal emission from CO₂, the mixing ratio of which is much more variable in space and time.

At microwave frequencies, radiance is directly proportional to the temperature of the emitting body. The radiometer output is usually converted to a temperature \( T_b \). The term "brightness temperature" acknowledges that the measurement is based on diathermal brightness that equals a thermometric temperature only when the measured object is a black body (unit emissivity, and thus zero absorption coefficient). While \( T_b \) is measured directly by the satellite, the true diathermal brightness involves three "sources":

1. Direct (upward) thermal emission by the atmosphere and smaller contributions from the surface back up to the satellite, and
2. Albedo (downward) atmospheric emission reflected from the surface back up to the satellite, and
3. Albedo (upward) atmospheric emission reflected from the surface back up to the satellite, and

\[ T_b(r) = \int_{p_{min}}^{p_{max}} T(p)(d \tau_r(p)/d \ln p) d \ln p \]


The integral is written in pressure coordinates, \( p \) is the surface pressure and \( T_e \) is the surface temperature. For conciseness, an "effective surface function" is defined which is virtually equal to the surface temperature anomalies observed during 1979–88.

\[ \tau_r(p) = \left[ 1 - (1 - e_s(\nu, \theta)) \right] \times (r_1(p)/r_2(p))^2 \]

where \( r_1(p) = r_1(p) \) and \( e_s \) represents the surface emissivity term in Eq. 1, \( e_s \) is the surface emissivity, \( \theta \) is the Earth incidence angle.

Equation 2 contains the atmospheric transmission factor, \( r_2(p) \), which is the exponential along the vertical path between the satellite and the troposphere. It is the ratio of the atmospheres at the troposphere at the observed wavelength. As a satellite instrument away from nadir (vertical), the increased absorption due to longer path lengths is accounted for by the instrument. Also, the contribution due to the reflection of the surface is contained in the term \( 1 - e_s \). As discussed below, a composite surface effect is contained in the surface emissivity, \( r_1(p) \), in Eq. 1.

In (1), \( T_b \) is expressed as a vertically integrated atmospheric temperature, where the transmission function is defined as \( -d \tau_r(p)/d \ln p \). In typical applications of the four channels of data, (1) is inverted to retrieve the atmospheric profile \( T(p) \). We depart from this by interpreting the MSU channel 2 and 4 \( T_b \) for nearly what they are, vertically averaged temperature measurement of the atmosphere. However, to
Global Sea Level Acceleration

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Greenhouse warming scenarios commonly forecast an acceleration of sea level rise in the next 5 or 6+ decades in the range 0.1–0.2 mm/yr². Long tide gauge records (75 years minimum) have been examined for past apparent sea level acceleration (i.e., deviation from a purely linear rise) and for indication of how long it might take to detect or verify a predicted future acceleration. For the 80-year period 1905–1985, 23 essentially complete tide gauge records in 10 geographic groups are available for analysis. These yielded the apparent global acceleration 0.011 (±0.002) mm/yr². A larger, less uniform set of 37 records in the same 10 groups with 92 years average length covering the 141 years from 1850 to 1991 gave for acceleration 0.001 (±0.0008) mm/yr². Thus there is no evidence for an apparent acceleration in the past 200+ years that is significant either statistically, or in comparison to values associated with global warming. Estimating how well a global acceleration parameter could be determined in a relatively short time was accomplished by dividing the 1905–1985 data set into four equal time spans. The formal 1σ uncertainty (about 0.2 mm/yr²) of global acceleration from these 20-year periods is more than an order of magnitude larger than for the 80- and 141-year cases owing to the existence of large interdecadal and longer variations of sea level. This means that tide gauges alone cannot serve as a leading indicator of climate change in less than at least several decades. Confirming the prediction of a particular model at the 95% confidence level by differentiating between model predictions will take much longer. The time required can be significantly reduced if the interdecadal fluctuations of sea level can be understood in terms of their forcing mechanisms and then removed from the tide gauge records.

1. INTRODUCTION

Global sea level rise is the subject of an extensive literature; excellent summary analyses are available in Sea Level Change [National Research Council (NRC), 1990] and the Intergovernmental Panel on Climate Change (IPCC) report Climate Change [Houghton et al., 1990]. Interest in sea level rise is high because of its obvious practical impact and its scientific value as a parameter of global change. In the latter respect, global sea level is similar to Earth orientation [Carter et al., 1989]. Both give measures that are necessary (but not sufficient) conditions for evaluating model predictions.

The IPCC report gives for the "business-as-usual" scenario of global warming an additional sea level change of 18 cm by 2010 and 44 cm by 2070, corresponding to accelerations of about 0.22 mm/yr² in the former case and 0.14 mm/yr² in the latter. Verification of these or similar predictions at an early date is necessary in order to establish confidence in climate models and forecasts.

Woodworth [1990] has investigated past apparent sea level acceleration and observed that the large number of tide gauges in the Baltic–Northern European region, although subject to linear vertical movements from glacial rebound, provided data suitable for study of the nonlinear component of sea level change. However, in his study he did not exploit the regional spatial correlation of the sea level signal at low frequencies, which has the effect of overemphasizing the importance of the very large number of tide gauges in northern Europe. We shall see below that a compact oceanic region containing records of varying lengths should be modeled by a linear trend for each tide gauge record along with a tide acceleration parameter that simultaneously satisfies (the sense of least squares) all records.

Woodworth [1990] also considered existing long records outside of Europe and concluded that there is little or no evidence for a statistically significant apparent acceleration of sea level in them. In addition, he attempted to show by an extrapolation of (meteorologically corrected) historic sea level residual data from the Newlyn, England, site that the acceleration in a region might be detected in about 3 decades, subject to certain assumptions concerning sea level variability. The present paper is less optimistic, taking note of the ubiquity of large chaotic regional sea level events that endure over a decade or more. These events can distort an estimate of regional sea level acceleration over even very long records and are devastating to records of a few decades' duration.

Before proceeding further, it is necessary to clarify what is meant in this paper, as well as in others such as Woodworth's [1990], by the term acceleration. This usage refers to the deviation of sea level from a linear trend over the data span in question that is modeled by an algebraic term of the second degree in time. It is necessary to explicitly state this because the true spectrum of sea level is red. This has the consequence that any particular span of sea level data, such as the period 1850 to 1991 presented considered in this paper, will represent an acceleration to a lesser or greater extent those low-frequency changes of sea level whose periods are significant in comparison to, or longer than, the data span. Thus the accelerations derived and referred to in this paper are really apparent ones, whose significance lies only in their amplitude relative to the acceleration predicted to accompany global warming.

Determinations of sea level acceleration suffer the same problems affecting determinations of the linear sea level rise value [Douglas, 1991], with an important exception, namely, vertical crustal movements. The most prevalent of these is postglacial rebound. This effect [Pelletier and Tushingham, 1989] is linear over the time span for which tide gauge data are available and is of no consequence in computation of the
acceleration in a record. Any other temporally linear vertical crustal movement, such as that associated with colliding tectonic plates at places with long earthquake recurrence times, is similarly not a factor. The result is that many more tide gauge records are useable for an analysis of apparent global sea level acceleration than in the case of the linear trend.

Although more gauges are available for analysis of apparent sea level acceleration than for the case of the linear rise, this is of little significance. The reason is that at low frequency, spatial coherence of sea level is very great. Thus a region such as the Baltic, although containing a score of long records, is effectively more like a single measurement system for interdecal to centennial and longer sea level variations. Figure 1 illustrates this phenomenon. The data are monthly mean values of sea level from the Permanent Service for Mean Sea Level (PSMSL) ([Spencer and Woodworth, 1991] that have been detrended over the common time period 1895–1963, and smoothed by a Gaussian filter with full width at half maximum (FWHM) of 4 years. Five typical sea level records in ascending order from the southernmost part of the Baltic northward to Stockholm and then well eastward into the Gulf of Finland are displayed. The temporal coherence of the records over decades is striking. This low-frequency "noise" corrupts a determination of acceleration from these records and is clearly not independent from one site to another. In addition, the records are obviously serially correlated in time at low frequencies, so that the standard deviation obtained for an acceleration parameter from an ordinary least squares fit to the data will be very optimistic. Such large and persistent oscillatory sea level events, present in most tide gauge time series, radically

![Fig. 1. Detrended and low-pass-filtered sea level records in the Baltic. Note the extraordinary coherence at low frequency.](image)

affect the value of apparent sea level acceleration derived from even very long records. How these events can affect a determination of sea level acceleration is shown in Figure 2. Presented are the filtered and detrended sea level records for Nedre Sodertalje and Stockholm, sites only about 25 km apart and with records nearly the same length at just over 90 years. The difference between them is that Nedre Sodertalje covers an earlier period reaching back into the 1860s during which another large persistent sea level event, verified by other old records, took place. Using the original unfiltered, monthly mean sea level (MSL) values for Stockholm and Nedre Sodertalje in a least squares fit to the function

$$\text{MSL} = (SA + A) + a + bt + 1/2ct^2$$

(where $SA$ and $A$ are semiannual and annual periodic terms, respectively, for the acceleration $c$. Although both give small values for acceleration, the earlier sea level event causes the acceleration derived from the Nedre Sodertalje sea level series to be 3 times that obtained from the Stockholm record. The difference in values is not negligible; if it were real, it would amount to 10 cm in 100 years. This shows that the sea level acceleration derived for a site depends on the data span; a question for even 100-year records and that the uncertainty of a result is dominated by the low-frequency sea level variations. Determining a meaningful global value requires using a well-distributed set of oceanic regions that have interregional coherence. For this paper, 10 regions were selected on a morphological basis by examining the regional sea level records. The average length of the records selected

![Fig. 2. Low-pass-filtered and detrended records for Stockholm and the point Nedre Sodertalje. Both records are more than 90 years in length but do not yield the same apparent sea level acceleration because of the somewhat different periods sampled.](image)
Regional and Global Apparent Sea Level Acceleration

In the previous paper by Douglas [1991] on global sea level rise, the condition was enforced that all records used had to be of at least 80% or complete because of the period of low-frequency sea level variations. From the comments above, it is clear that the apparent acceleration determined for a site can also be affected by a data gap, so the same condition was applied for this analysis.

As we have seen, record length is a critical parameter in the selection of data sets. Figure 3 shows how record length affects the apparent acceleration estimate by displaying it as a function of data span for PSMSL records >10 years long. The scatter of accelerations for records less than about 40 years is very great; the reason for the striking increase in consistency beginning with records >50 years is unknown. Of course, the scatter of shorter records in Figure 3 is due to the uncertainties in the interpolation or small numbers of the data span. However, the uncertainty in the acceleration estimate due to the uncertainties in the acceleration parameter estimate is low. The figure clearly shows the site dependence of apparent sea level acceleration for records even many decades in length.

Although the disparity of values in Figure 3 is discouraging, it is worth pointing out that the number of values with short records available is very large, since many new gauges have been installed in recent decades. The oceanic regions selected in this paper with records >75 years in length do not represent what is possible for the recent past or near future, but as can be seen in the example of the Baltic, a new tide gauge is really only significant for the sea level trend and acceleration problem if it is located in a new area not previously sampled. Even allowing for some argument as to what constitutes an oceanic region, it is unlikely that their numbers could be doubled from the number (100 chosen for this paper). Since a doubling of independent samples only reduces the error of the mean by 40%, the importance of understanding and eliminating interdecadal and longer low-frequency variations of sea level is underscored.

Table I presents the groups of stations used for an analysis of apparent sea level acceleration during the period approximately 1850-1990. The largest group is the one covering the North Sea at Esbjerg on into the Baltic entrance and thence to the Gulf of Finland. Four of the groups contain only one station. We shall see below that the disparity of numbers of stations between groups is far less important than might be supposed.

If Table I is compared with the list of stations used by Douglas [1991] it will be seen that other new stations are used in this paper in addition to those in the Baltic. In the previous work, Bombay, Tokyo, and Seattle were rejected on the basis of vertical crustal movements, and Sydney was eliminated because of differences with a nearby site over an extended interval. The situation in the present investigation for Seattle is straightforward. Comparison of detrended records for Seattle and nearby gauges over a common time period shows a very high degree of consistency at low frequencies, indicating that the longer Seattle record is representative of the entire region as far as nonlinear changes are concerned.

The situation is more ambiguous for Bombay because very large differences in sea level variations exist over the common time interval. But Bombay is not the site of frequent earthquakes, so vertical crustal movements should be absorbed into the linear trend value. The remaining site, Tokyo, was added to the list because after detrending, the record shows no obvious breaks that might have resulted from a large earthquake.

The remaining new sites used in this paper are Auckland, New Zealand; Sydney, Australia; and Buenos Aires, Argentina. The first has been reported on by Håkanson [1990], who kindly made available the monthly mean values for use in this paper. The determined Auckland record closely resembles that of Sydney at low frequencies, so the two are considered to be in a single region, and the quality of the Sydney record is verified by the absence of unusual values. Buenos Aires was previously unavailable.

Accelera parameters for each record are shown in Table 1 in the last column. There is some scatter, but the majority of values are far less in absolute value than the predicted future acceleration of sea level rise of about 0.2 mm/yr. It is also worth noting that the 37 values are evenly distributed as to sign. Table 1 suggests that the apparent acceleration of sea level in the last 100 years has been small but cannot identify the sign.

The apparent acceleration of sea level for individual groups in Table 1 was estimated according to the following scheme. For each group, a unique trend for every station and an acceleration satisfying all stations were estimated simultaneously. Thus records of disparate length in a group are correctly weighted, and the records that reach very far back will influence the calculated value of acceleration for the group. The group accelerations are given in Table 2. Note that they are also evenly divided as to sign.
<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
<th>Start</th>
<th>End</th>
<th>Span, years</th>
<th>Acceleration, mm/yr²</th>
</tr>
</thead>
<tbody>
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<td>Goteborg</td>
<td>57°43'N</td>
<td>11°57'E</td>
<td>1887</td>
<td>1969</td>
<td>82</td>
</tr>
<tr>
<td>Varberg</td>
<td>57°06'N</td>
<td>12°13'E</td>
<td>1887</td>
<td>1982</td>
<td>95</td>
</tr>
<tr>
<td>Ystad</td>
<td>55°25'N</td>
<td>13°49'E</td>
<td>1887</td>
<td>1982</td>
<td>93</td>
</tr>
<tr>
<td>Kungsholmsfort</td>
<td>56°06'N</td>
<td>15°35'E</td>
<td>1887</td>
<td>1982</td>
<td>95</td>
</tr>
<tr>
<td>Landsort</td>
<td>58°42'N</td>
<td>17°52'E</td>
<td>1889</td>
<td>1966</td>
<td>97</td>
</tr>
<tr>
<td>Neder Söderlje</td>
<td>59°12'N</td>
<td>17°37'E</td>
<td>1889</td>
<td>1982</td>
<td>93</td>
</tr>
<tr>
<td>Stockholm</td>
<td>59°19'N</td>
<td>18°03'E</td>
<td>1889</td>
<td>1982</td>
<td>83</td>
</tr>
<tr>
<td>Bjorn</td>
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<td>17°58'E</td>
<td>1892</td>
<td>1970</td>
<td>90</td>
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<td>Raan</td>
<td>64°00'N</td>
<td>20°55'E</td>
<td>1892</td>
<td>1988</td>
<td>99</td>
</tr>
<tr>
<td>Oulu/Uleaborg</td>
<td>63°02'N</td>
<td>25°23'E</td>
<td>1889</td>
<td>1988</td>
<td>104</td>
</tr>
<tr>
<td>Vaasa/Vasa</td>
<td>63°06'N</td>
<td>21°31'E</td>
<td>1883</td>
<td>1988</td>
<td>79</td>
</tr>
<tr>
<td>Lyokki</td>
<td>60°51'N</td>
<td>21°11'E</td>
<td>1883</td>
<td>1937</td>
<td>79</td>
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<tr>
<td>Lysyrtii</td>
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<td>21°14'E</td>
<td>1883</td>
<td>1937</td>
<td>79</td>
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<td>Helsinki</td>
<td>60°09'N</td>
<td>24°58'E</td>
<td>1879</td>
<td>1988</td>
<td>109</td>
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<td>Kopenhagen</td>
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<td>12°36'E</td>
<td>1889</td>
<td>1970</td>
<td>81</td>
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<tr>
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<td>9°46'E</td>
<td>1889</td>
<td>1970</td>
<td>80</td>
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<td>10°13'E</td>
<td>1888</td>
<td>1969</td>
<td>81</td>
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<td>Estbjerg</td>
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<td>8°27'E</td>
<td>1889</td>
<td>1970</td>
<td>81</td>
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<td>Aberdeen</td>
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<td>1966</td>
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<td>North Shields</td>
<td>55°09'N</td>
<td>1°27'E</td>
<td>1895</td>
<td>1991</td>
<td>96</td>
</tr>
<tr>
<td>Newlyn</td>
<td>50°06'N</td>
<td>5°53'E</td>
<td>1915</td>
<td>1991</td>
<td>76</td>
</tr>
<tr>
<td>Breit</td>
<td>48°23'N</td>
<td>4°30'E</td>
<td>1807</td>
<td>1991</td>
<td>184</td>
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<tr>
<td>Cascais</td>
<td>38°41'N</td>
<td>9°25'E</td>
<td>1882</td>
<td>1987</td>
<td>106</td>
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<td>Marseille</td>
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<td>5°21'E</td>
<td>1883</td>
<td>1988</td>
<td>103</td>
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<tr>
<td>Genoa</td>
<td>44°24'N</td>
<td>8°54'E</td>
<td>1884</td>
<td>1989</td>
<td>105</td>
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<tr>
<td>Trieste</td>
<td>45°59'N</td>
<td>13°45'E</td>
<td>1905</td>
<td>1986</td>
<td>86</td>
</tr>
<tr>
<td>Bombay</td>
<td>18°53'N</td>
<td>72°50'E</td>
<td>1878</td>
<td>1987</td>
<td>109</td>
</tr>
<tr>
<td>Tonoura</td>
<td>34°54'N</td>
<td>132°04'E</td>
<td>1894</td>
<td>1984</td>
<td>90</td>
</tr>
<tr>
<td>Sydney</td>
<td>33°51'S</td>
<td>151°14'E</td>
<td>1897</td>
<td>1991</td>
<td>94</td>
</tr>
<tr>
<td>Auckland</td>
<td>36°51'S</td>
<td>174°46'E</td>
<td>1904</td>
<td>1989</td>
<td>85</td>
</tr>
<tr>
<td>Honolulu</td>
<td>21°19'N</td>
<td>157°32'W</td>
<td>1905</td>
<td>1989</td>
<td>84</td>
</tr>
<tr>
<td>Seattle</td>
<td>47°36'N</td>
<td>122°29'W</td>
<td>1899</td>
<td>1989</td>
<td>90</td>
</tr>
<tr>
<td>San Francisco</td>
<td>37°48'N</td>
<td>122°28'W</td>
<td>1854</td>
<td>1989</td>
<td>134</td>
</tr>
<tr>
<td>San Diego</td>
<td>32°43'N</td>
<td>117°10'W</td>
<td>1906</td>
<td>1989</td>
<td>83</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>34°36'S</td>
<td>58°22'W</td>
<td>1905</td>
<td>1988</td>
<td>83</td>
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<td>Baltimore</td>
<td>39°16'N</td>
<td>76°31'W</td>
<td>1902</td>
<td>1989</td>
<td>86</td>
</tr>
<tr>
<td>New York</td>
<td>40°42'N</td>
<td>74°01'W</td>
<td>1836</td>
<td>1989</td>
<td>133</td>
</tr>
</tbody>
</table>

The average record length is 92 years. Apparent accelerations are for the entire records.

The standard deviations shown in Table 2 for the individual group acceleration parameters are based on an estimate of the noise level of the data and have been adjusted to give an posterior variance of unit weight of 1. Of course the larger groups give more precise results because of the huge number of values in them. But not too much should be made of these formal uncertainties because they are based on the usual least squares assumption that the data noise is Gaussian and independent between sea level series in each group, assumptions clearly unwarranted for estimates of acceleration. Thus the mean acceleration of the groups shown in Table 2 was calculated giving each group equal weight. These 10 groups should give a more meaningful estimate of mean global apparent sea level acceleration and its uncertainty because their individual estimates are more statistically independent than the member stations in a region. The larger groups give more precise results because of the huge number of values in them. But not too much should be made of these formal uncertainties because they are based on the usual least squares assumption that the data noise is Gaussian and independent between sea level series in each group, assumptions clearly unwarranted for estimates of acceleration. Thus the mean acceleration of the groups shown in Table 2 was calculated giving each group equal weight. These 10 groups should give a more meaningful estimate of mean global apparent sea level acceleration and its uncertainty because their individual estimates are more statistically independent than the member stations in a region. From Table 2 we conclude that at the 95% confidence level the mean apparent acceleration across all groups is less than 10% of the acceleration anticipated in global warming scenarios for the future.

The largest apparent accelerations in Table 2 are for Tonoura, Japan, and Buenos Aires, Argentina. Tonoura has a relatively smooth record that is concave downward (Dou-
TABLE 3. Stations With Nearly Complete Records From 1905–1985

<table>
<thead>
<tr>
<th></th>
<th>Latitude</th>
<th>Longitude</th>
<th>Acceleration, mm/yr⁻¹</th>
<th>Group</th>
<th>Acceleration</th>
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<tbody>
<tr>
<td>Varberg</td>
<td>57°06'N</td>
<td>12°13'E</td>
<td>-0.028</td>
<td>Group 1</td>
<td></td>
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<tr>
<td>Ystad</td>
<td>55°25'N</td>
<td>13°49'E</td>
<td>-0.017</td>
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<td>-0.001</td>
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<td>Kungsholmsfort</td>
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<td>15°55'E</td>
<td>0.031</td>
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<td></td>
</tr>
<tr>
<td>Landsort</td>
<td>58°45'N</td>
<td>17°52'E</td>
<td>0.029</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stockholm</td>
<td>59°19'N</td>
<td>18°03'E</td>
<td>-0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratan</td>
<td>64°00'N</td>
<td>20°55'E</td>
<td>-0.019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oulu/Uleåborg</td>
<td>65°22'N</td>
<td>23°25'E</td>
<td>-0.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vasa/Vasa</td>
<td>62°06'N</td>
<td>21°34'E</td>
<td>-0.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helsinki</td>
<td>60°09'N</td>
<td>24°56'E</td>
<td>0.014</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>North Shields</td>
<td>53°00'N</td>
<td>1°27'W</td>
<td>-0.027</td>
<td>Group 2</td>
<td>-0.024</td>
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<td>Cascais</td>
<td>38°41'N</td>
<td>9°25'W</td>
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<td></td>
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<td>Trieste</td>
<td>45°39'N</td>
<td>13°43'E</td>
<td>-0.011</td>
<td>Group 3</td>
<td>-0.011</td>
</tr>
<tr>
<td>Bombay</td>
<td>18°55'N</td>
<td>72°50'E</td>
<td>-0.084</td>
<td>Group 4</td>
<td>-0.084</td>
</tr>
<tr>
<td>Tousourea</td>
<td>34°54'N</td>
<td>112°04'E</td>
<td>-0.064</td>
<td>Group 5</td>
<td>-0.064</td>
</tr>
<tr>
<td>Sydney</td>
<td>33°51'S</td>
<td>151°14'E</td>
<td>0.047</td>
<td>Group 6</td>
<td>0.019</td>
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<tr>
<td>Auckland</td>
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<td></td>
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<td>Honolulu</td>
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<td>-0.013</td>
<td>Group 7</td>
<td>-0.013</td>
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<tr>
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<tr>
<td>San Francisco</td>
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<td>122°28'W</td>
<td>0.029</td>
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<td></td>
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<tr>
<td>San Diego</td>
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<td>117°10'W</td>
<td>0.019</td>
<td></td>
<td>0.031</td>
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<tr>
<td>Buenos Aires</td>
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<td>58°22'W</td>
<td>0.041</td>
<td>Group 9</td>
<td>0.041</td>
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<tr>
<td>Baltimore</td>
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<td>76°35'W</td>
<td>-0.011</td>
<td>Group 10</td>
<td>-0.013</td>
</tr>
<tr>
<td>New York</td>
<td>40°42'N</td>
<td>74°01'W</td>
<td>-0.015</td>
<td></td>
<td>0.011 ± 0.012</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The formal uncertainty of each record is about the same as at about 0.015 mm/yr⁻¹. The mean apparent acceleration of the groups is -0.011 (±0.012) mm/yr⁻¹, with the uncertainty calculated from the scatter about the mean.
constituting the 1905–1985 data set into four 20-year subsets and determining the global acceleration parameter for each is shown in Table 4. What we see is what Figure 3 suggests: the uncertainty of apparent global sea level acceleration determined from 20-year records is more than an order of magnitude greater than for 50- to 80-year series and is comparable to the acceleration of sea level anticipated by climate models.

3. Discussion

This paper has considered the apparent acceleration of sea level in regions and used an estimation scheme for each region that determines simultaneously a trend for each station in the region and an acceleration parameter for the entire region. This procedure should give a more optimal estimate of apparent acceleration in an area with records of disparate length. The conclusion reached is, however, the same as that of Woodworth (1990) in his more straightforward analysis of European records. He also concluded that there is evidence of an acceleration effect in sea level in the historical record that is in any way comparable to that associated with most global warming predictions for the future.

An issue as interesting as the apparent past acceleration of sea level is whether or not sea level can be used as a “leading indicator” of climate change either regionally or globally. Since an acceleration of 0.2 mm/yr² amounts to only 1 cm in 10 years and 4 cm in 20 years, the outlook for tide gauge measurements by themselves is clearly not good. These values are small compared with the interannual-interdecadal variations of sea level, casting doubt that a useful index of sea level acceleration can be obtained relatively quickly. This observation is entirely consistent with Figure 3 and the results given in Table 4 for the uncertainty of global acceleration derived from 20-year records. As noted previously, for records less than a few decades, the acceleration parameter shows the low-frequency variations of sea level and gives a fictitious result.

Woodworth (1990) also emphasizes the importance of the interannual-interdecadal variability of sea level on attempts at calculating sea level acceleration. However, he goes on to construct a simulated Newlyn sea level record consisting of the past linear trend there and that part of the historic Newlyn sea level series unexplained by meteorological forcing, plus an extrapolated portion into the future that includes a positive acceleration. He then concludes from an analysis of 60 years of these simulated Newlyn data up to 2010 that evidence of an acceleration of the magnitude expected to accompany global warming should be detected at the 95% confidence level by that time. However, in his Figure 4, which displays the simulated sea level series for Newlyn, one notes that the projected series touches the historic trend line in about 2030 due to the residual interdecadal signal, casting some doubt on the robustness of his conclusion. Fortunately, as Woodworth (1990) points out and is clearly obvious in his Figure 2, by 2030 the acceleration should be readily detected in his scenario using only the previous 30 or so years of data. By 2050 the acceleration in his simulation has caused an accumulated change of sea level that deviates markedly from the historic linear trend.

Although the Newlyn simulation gives an encouraging result for the potential of tide gauges to detect regional sea level acceleration, as Woodworth (1990) explains, the validity of the simulation procedure depends critically on the future unmodeled interannual-interdecadal signal being like that of the past. The low-pass-filtered Newlyn record is remarkably stationary in appearance over the data span compared to many tide gauge records, but that span is not indicative of what has actually occurred there. Figure 4, comparing Newlyn and Brest sea level series, shows that a large unpredictable sea level event, that is, a large rise and fall lasting a decade or more, occurred just before the Newlyn series began. This event is verified by the North Shields records. If this event happened again, it could be mistaken for the beginning of an enduring acceleration of sea level, or at the least would have a corrupting influence on the derived acceleration of sea level. These interdecadal events are not unusual in any region (consider the Baltic records in Figure 1), nor do they have a simple explanation in terms of meteorological forcing; steric effects are also involved and in general will be far larger in magnitude than meteorological ones at very low frequencies. Because of these events, it will be necessary to consider as many ocean regions as possible, as was done in this paper, and attempt to extract any underlying new trend of acceleration.

It is interesting to consider what can be gained from a few decades of Newlyn sea level values by analyzing actual (i.e., uncorrected for meteorological forcing) Newlyn data from 1950–1982. The result for the acceleration is -0.002 ± 0.12 mm/yr². The 95% confidence interval is thus about 0.24, a little larger than the value (0.2 mm/yr²) anticipated for the acceleration that may result from global warming. Such a result clearly demonstrates the absolute necessity of understanding the source of the low-frequency variations of sea level in tide gauge records. The Newlyn data show that an acceleration at a site cannot be determined to a degree useful for evaluating regional climate model forecasts in even 3 decades from sea level records whose low frequency variations are not well understood.

4. Conclusions

Consideration of a global set of tide gauge records made since 1850 leads to the conclusion that the apparent acceleration of sea level since that time has been small and much less than the real acceleration predicted to accompany greenhouse warming. However, confidently determining the future value of global sea level acceleration from tide gauge data alone would appear to require something approaching 50 years, according to the results quoted earlier for a 50-year global solution, and by inference from Figure 3. But this is
followed by deviant sea level values. For this paper, Brest data were eliminated from 1939 until 1958. This results in a long gap in the Brest record, too long for an analysis of the 1905-1985 time period.

The situation for Marseille during 1905-1985 is presented in Figure 5. As shown, the Marseille sea level record deviates sharply from Trieste (about 500 km distant) beginning in about 1945, suffers a data gap, and then reappears in good agreement after about 1970. In contrast, Trieste agrees well with Genoa during this time (and over all of the time they have in common) in spite of being on opposite sides of the Italian peninsula. It was concluded that the Marseille record is faulty during 1945-1958, and so the entire series was eliminated because of the large gap. Genoa was also eliminated because it covers only a limited portion of the period 1905-1985.

The acceleration parameter estimates for the period 1905-1985 are shown in the last column of Table 3. Both the mean value and the uncertainty are larger than in the case of the longer records, and once again, it can only be concluded that the deviation from a linear rise is small compared with the acceleration predicted to accompany global warming.

Figure 3 suggests that a record as short as 50 years should give a small uncertainty for acceleration. This is verified by computing a solution for the apparent mean acceleration of the 10 groups in Table 3 from 1935 to 1985. The result is $0.003 \pm 0.003$ mm/yr$^2$. Shorter spans are less encouraging.

The result of subdividing the consistent set of records

**Fig. 4.** Detrended and filtered sea level records for Brest (dots) and Newlyn (solid line). Note the departure of the records in 1939 just prior to the gap.

**Fig. 5.** Detrended and filtered sea level for Marseille (dots) and Trieste (solid line). The records agree well until about 1945, at which time Marseille deviates sharply from Trieste. The latter agrees well with Genoa during this time, indicating a problem with the Marseille record.
too pessimistic for a final conclusion about using sea level as an indicator of global warming. Since the problem lies in the large interannual-interdecadal variations of sea level, these must be measured or modeled and removed from the data. This has been accomplished for one site, Bermuda, for a few decades. Roemmich [NRC, 1990] shows that the O (10 cm) interdecadal variations of sea level there are explained by the density changes above 2000 m depth to within the accuracy of the measurements. It seems clear that a relatively small number of islands and properly selected coastal tide gauges well distributed around the globe, at which the effects of meteorological forcing and the ocean’s (perhaps complex) response are thoroughly understood, might give a reliable estimate of sea level acceleration in a much shorter time than tide gauge data alone.

Finally, satellite altimetry offers a new method for observing low-frequency variations of sea level. Even though the accuracy of point values of sea level variation from satellite data is lower than that of tide gauges, the global coverage given by satellites has the potential of yielding a very precise value of global sea level. Cheney et al. [1991] have obtained agreement of 3-4 cm (rms) with individual island tide gauges for Geosat monthly mean values of sea level. Miller and Cheney [1990] have shown that much better regional results are possible. They obtained 9-mm (rms) agreement between the average of 14 tropical Pacific gauges and the average of corresponding Geosat sea level series. A coordinated effort consisting of tide gauge measurements, altimetric satellites, meteorological data, water column density observations, and modeling should enable an acceleration of sea level to be observed soon enough to be of value in evaluating climate models and forecasts.

Acknowledgments. I wish to thank Ed Herbstreiths for making the computations for this paper. This investigation was carried out under the auspices of the U.S. Global Climate and Global Change Program directed by the NOAA Office of Global Programs.

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(Received February 10, 1992; revised April 15, 1992; accepted April 28, 1992.)
Viewpoint

Does CO₂ really drive global warming?

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Published

In

Chemical Innovation
Vol. 31 (#5: May): pp. 44-46; 2001

A journal of the American Chemical Society
Editor: Michael Block [myb96@acs.org]

May 2001
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Viewpoint

Does CO₂ really drive global warming?

I don’t believe that it does.

To the contrary, in applying the IFF test – if-and-only-if or necessary-and-sufficient – the outcome would appear to be exactly the reverse. Rather than the rising levels of CO₂ driving up the temperature, the logical conclusion is that it is the rising temperature that is driving up the CO₂ level. Of course, this raises a raft of questions, but all are answerable nevertheless. What is particularly critical is distinguishing between the observed phenomenon, or the “what”, from the governing mechanism, or the “why”. Confusion between these two would appear to be the source of much of the noise in the Global Warming debate.

In applying the IFF test we can start with the clear correlation between the global CO₂ profile and the corresponding temperature signature. There is now in the literature a 400,000 year sequence clearly showing, as a phenomenon, that both go up – and down – together (1). The correlation is clear and accepted. But the causation, the mechanism, is something else: Which is driving which?

Logically, there are four possible explanations, but only two need serious consideration unless they both fail.

- Case 1: CO₂ drives the temperature as is currently mostly frequently asserted;

and

- Case 2: Temperature drives the CO₂ levels.

Both appear at first to be possible, but both then generate crucial origin and supplementary questions. For Case 1, the origin question is: What, independently, is the source of the CO₂, that is then rising and falling, and which then, somehow, is presumed to drive the temperature up and down. For Case (2) it is: What is the driver for the temperature changes; and if this then drives the CO₂, then where does the CO₂ come from? For Case 2, the questions are answerable, but for Case 1 they are not.

Consider Case 2. This directly introduces the global warming behavior. Is global warming, a separate and independent phenomenon, in progress? The answer, as I heard it in geology class 50 years ago, was “yes”, and I have seen nothing since then to contradict that position. To the contrary, as further support, there is now documentation (that was only fragmentary 50 years ago) of an 850,000 year global-temperature sequence, showing that the temperature is oscillating with a period of 100,000 years, and with an amplitude that has risen, in that time, from about 5 deg-F at the start to about 10 deg-F “today” (meaning the latest 100,000 year period) (2). We are currently in a rise that started 25,000 years ago and, reasonably, can be expected to peak “very shortly”.

On the shorter time scales of 1000 years and 100 years, further temperature oscillations are to be seen, but of much smaller amplitude, down to 1 deg-F and 0.5 deg-F in those two cases. Nevertheless, the overall trend is clearly up, even through the Little Ice Age (~1350 – 1700 AD).
following the Medieval Warm Period. So the global warming phenomenon is here, with a very long history, and we are in it. But what is the Driver?

**Arctic Ocean Model**

The postulated Driver, or mechanism, developed some 30 years ago to account for the "million-year" temperature oscillations, is best known as the "Arctic Ocean" model (2). According to this model, the temperature variations are driven by an oscillating ice cap on the northern polar regions; and the crucial element in conceptual formulation of this mechanism was the realization that such a massive ice cap could not have developed, and then continued to expand through that development, unless there was a major source of moisture close by, to supply, maintain, and extend the cap. The only possible moisture source was then identified as the Arctic Ocean which, therefore, had to be open — not frozen over — during the development of the ice ages. And it then closed again, stopping the moisture supply, by freezing over during the warming retreats.

So the model we now have is that if the Arctic Ocean is frozen over, as is the case today, the existing ice cap is not being replenished and must shrink, as it is doing today. As it does so, the earth can then absorb more of the sun’s radiation and therefore will heat up — global warming — as it is doing today, so long as the Arctic Ocean is closed. When it is warm enough for the Ocean to open, which the oceanographic (and media) reports say is evidently happening right now, then the Ice Cap can start to reform.

As it expands, the ice increasingly reflects the incoming (shorter-wave) radiation from the sun so that the atmosphere cools. But then, the expanding ice cap reduces the (longer-wave) radiative loss from the Earth, acting as an insulator, so that the earth below cools more slowly and can keep the ocean open although the ice cap is expanding. This generates “out-of-sync” oscillations between atmosphere and earth. The Arctic Ocean “trip” behavior at the temperature extremes, allowing essentially discontinuous change in direction of the temperature, is identified as a bifurcation system with potential for analysis as such. The suggested trip times for the change are interesting: They were originally estimated at about 500 years, then reduced to 50 years and, as the most recent, down to 5 years. So, if the Ocean is opening right now, we could possibly start to see the temperature reversal under way in about 10 years.

What we have here is a Sufficient mechanistic explanation for the dominant temperature fluctuations and, particularly, for the current global warming rise — without the need for CO₂ as a driver. Given that pattern, the observed CO₂ variations then follow, as a driven outcome, mainly as the result of change in dynamic equilibrium between the CO₂ concentration in the atmosphere and its solution in the sea. The numbers are instructive. The 1995 IPCC data on the carbon balance show ~ 90 Gigatons of carbon in annual quasi-equilibrium exchange between sea and atmosphere, and back again; and an additional 60 Gigatons exchange between vegetation and atmosphere giving a total of ~ 150 Gt (4). This interpretation of the sea as the major source is also in-line with the famous Mauna Loa CO₂ profile for the last 40 years showing the consistent season-dependent variation of 5 or 6 ppm, up and down, through the year — when the average global rise is only 1 ppm per year.

This oscillation is attributed in the literature to seasonal growing behavior on the “Mainland” (5), which is mostly China, > 2000 miles away; but no such profile with that amplitude is known to have been reported at any mainland location. Also, the amplitude would have to fall due to turbulent diffusive exchange during transport over the 2000 miles from the
Mainland to Hawaii, but again there is lack of evidence for such behavior. The fluctuation can, however, be explained simply from study of solution equilibria of CO₂ in water as due to emission of CO₂ from and return to the sea round Hawaii governed by a +/-10 deg-F seasonal variation in the sea temperature.

Man's impact

The next matter is the impact by man from fossil fuel combustion. Returning to the IPCC data and putting a rational variation as noise of about 5 Gt on those numbers, this float is then of the order of the further – almost trivial (< 5%) – annual contribution of 5-6 Gt from combustion of fossil fuels. This means that fossil fuel combustion can not be expected to have any significant influence on the system unless, to introduce the next point of focus, the radiative balance is at some extreme or bifurcation point that can be tripped by "small" concentration changes in the radiation absorbing-emitting gases in the atmosphere. Can that include CO₂?

This now starts to address the Necessity or "only-if" elements of the problem. The question focuses on whether CO₂ in the atmosphere can be a dominant, or "only-if" radiative-balance gas; and the answer to that is rather clearly "no". The full detailed support for that statement takes the argument into some largely esoteric areas of radiative behavior, including analytical solution of the Schuster-Schwartzchild Integral Equation of Transfer that governs radiative exchange (5-7), but the outcome is clear.

The central point is that the major absorbing gas in the atmosphere is water, not CO₂, and although CO₂ is also the only other significant atmospheric absorbing gas, it is still only a minor contributor on account of its relatively low concentration. The radiative absorption "cross-sections" for water and CO₂ are so similar that their relative influence depends primarily on their relative concentrations. Indeed, although water is actually stronger, for many engineering calculations, the concentrations of the two gases are added, and the mixture is treated as a single gas.

In the atmosphere, the molar concentration of CO₂ is in the range 350 to 400 ppm. Water, on the other hand, has a very large variation but, using the "60/60" [60% RH at 60 deg-F] value as an average, then from the standard American Society of Heating, Refrigerating, and Air-Conditioning Engineers Psychrometric Chart, the weight ratio of water to dry air is ~ 0.0065, or roughly 10,500 ppm on a molar basis. Compared with CO₂, this puts water, on average, at 25-30 times the (molar) concentration of the CO₂, but it can range from a 1:1 ratio to > 100:1.

Even closer focus on this is given by solution of the Schuster-Schwartzchild Equation of Transfer applied to the U.S. Standard Atmosphere profiles for the variation of air temperature, pressure, and density with height (8). The results show that the average absorption coefficient obtained for the atmosphere closely corresponds to that for the 5.6 to 7.6 μm water radiation band, with the water concentration in the range 60 to 80% RH which is on-target for atmospheric conditions. The absorption coefficient is, correspondingly, one to two orders of magnitude higher than the coefficient values for the CO₂ bands at a concentration of 400 ppm. This would seem to eliminate CO₂ and thus provide a closure on that argument.

This overall position can be summarized by saying that water accounts, on average, for >95% of the radiative absorption. And because of the variation in the absorption due to the variation in the water, then anything CO₂ might do in the future by increase in its concentration, water will already have done. The common objection to that argument is that the wide
fluctuations in the water make an averaging (for some reason) impermissible. Yet such averaging is applied without objection to global temperatures where the actual temperature variation across the Earth from poles to equator is roughly -100 deg-F to +100 deg-F, and a change in the average of ±1°F is considered major and significant. If this averaging procedure can be applied to the atmospheric temperature, it can be applied to the atmospheric water content, and if it is denied for water it must, likewise, be denied for the temperature — and then we don’t have an identified problem!

What the evidence shows

So what we have on the best current evidence is that:

- global temperatures are currently rising;
- the rise is part of a nearly million-year oscillation with the current rise beginning some 25,000 years ago;
- that the trip or bifurcation behavior at the temperature extremes are attributable to the “opening” and “closing” of the Arctic Ocean;
- that there is no need to invoke CO₂ as the source of the current temperature rise;
- that the dominant source and sink for CO₂ is the ocean, accounting for about two-thirds of the exchange, with vegetation as the major secondary source and sink;
- that if CO₂ were the temperature-oscillation driver, no mechanism – other than the separately-driven temperature (which would then be a circular argument) – has been proposed to account independently for the CO₂ rise, and fall, over the 400,000 year period;
- that the CO₂ contribution to atmosphere from combustion is inside the statistical noise of the major sea and vegetation exchanges so a priori it can not be expected to be statistically significant
- that water – as gas not condensate or cloud – is the major radiative absorbing/emitting gas (averaging 95%) in the atmosphere, not CO₂;
- that extraction of the radiation absorption coefficients identifies water as the primary absorber in the 5.6 to 7.6 µm water band in the 60 to 80% RH range; and
- that the absorption coefficients for the CO₂ bands at the 400 ppm concentration are one to two orders of magnitude too small to be significant even if the CO₂ concentration was doubled.

The outcome is that the global warming advocate’s conclusion on the role of CO₂ evidently has it back to front: It’s the temperature that is driving the CO₂. If there are flaws in these propositions, I’m listening, but if there are objections, let’s have them with the numbers.

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000139
Coherence established between atmospheric carbon dioxide and global temperature

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The hypothesis that the increase in atmospheric carbon dioxide is related to observable changes in the climate is tested using modern methods of time-series analysis. The results confirm that average global temperature is increasing and that temperature and atmospheric carbon dioxide are significantly correlated over the past thirty years. Changes in carbon dioxide content lag those in temperature by five months.

DURING the past century (see, for example, refs 1, 2), scientists have studied the possibility that the climate is influenced by changes in the atmospheric concentration of CO₂ caused by industrial and agricultural activities3,4. Recently, because of the potentially serious consequences of the greenhouse effect, the problem has received more attention with a view towards observing climatic effects attributable to the increase of atmospheric greenhouse gases. For example, the output of numerical models of the global climate has been compared with measurements5,6, and the significance of the temperature increase has been tested using various straight-line segment and parametric models (ref. 12 and J. Searle, manuscript in preparation). But present numerical models of the atmosphere are crude, and comparisons between the time series representing the real data and predictions of the atmospheric models are difficult to interpret. Because the available data are short time series, conventional statistical methods are unreliable, and detection of the greenhouse effect remains controversial7-18.

The longest modern series of precise CO₂ concentration measurements begins in March 1958 and consists of monthly values collected by Keeling at the summit of Mauna Loa in Hawaii19. Although these data are from a single station, they are typical of measurements made since 1974 at several sites20. Because we are interested in the time-series aspects of the problem, we use the longer Keeling series. The data have an upward trend that is readily visible (the upper curve in Fig. 1), an obvious annual component and irregular fluctuations. Five missing values were interpolated using a stochastic least-squares procedure on the residuals from a quadratic polynomial plus the first five annual harmonics. These interpolated values have an estimated error of 0.35 p.p.m. and are noted in Fig. 1.

Hansen and Lebedeff21, created a time-series of monthly global-average surface-air-temperature changes from January 1880 to December 1988. This series is a weighted average over 87 stations, formed by subtracting the average January temperature during the reference period 1951-80 from all the January data, and repeating this for the other months, eliminating seasonal variations. Displayed as the lower curve in Fig. 1, the temperature series also increases with time but its fluctuations are relatively larger than those in the CO₂ record20.

Here we apply multiple-window time-series methods (which are intended for short series) to estimate the trends and power spectrum of the Hansen-Lebedeff average global surface temperature series and Keeling CO₂ concentration measurements, as well as the coherence between the two. This analysis shows that from 1880 to 1988, the average global temperature increased by 0.0055±0.0009°C yr⁻¹, and the probability that this slope is positive exceeds 99.99%. Furthermore, the monthly CO₂ concentration and global temperature series from 1958 to 1988 are coherent over much of the Nyquist frequency band from 0 to 6 cycle yr⁻¹; the probability that the level of coherence observed from 0 to 2 cycle yr⁻¹ occurred by chance is ~2×10⁻⁶. Not only do both series have increasing trends that are highly significant, but there are linear relations between many of their oscillatory components. We interpret this as evidence that the changes in atmospheric CO₂ concentration are closely related to changes in global temperature.

Models

Many of the contradictions in the literature about the analysis of climate data can be traced to the use of inappropriate or oversimplified models (for review, see, for example, refs 22, 23). Statistical techniques that are vulnerable to difficulties include those based on parametric models (such as low-order autoregressive moving-average representations) and methods plagued by more insidious problems caused by implicit assumptions of time-series stationarity. The cavalier use of parametric models can lead to specification difficulties24 because

FIG. 1 The upper curve is the monthly Keeling CO₂ concentration data for March 1958 to December 1988. The five interpolated points are marked. The lower curve is the Hansen-Lebedeff average global temperature series for 1880 to 1988. The short line segments and hyperbolic arcs define trends and 95% confidence regions over 35-year intervals, and the long straight line shows the general trend.
have a non-white (non-flat) spectrum and are therefore correlated. The residual spectrum need only be roughly in a small frequency interval around the origin for the double window regression, however, to produce valid estimates of \(a_n\), the spectrum of the residuals and their errors.

Multiple windows

The multiple-window method uses the orthogonal sequences \(N\) elements that optimally concentrate the spectral energy in the frequency band of width \(2B\) centred on a frequency \(f\) between the frequencies \(f-B\) and \(f+B\). These sequences are the lowest-order \([2, \ldots, 7]\) discrete prolate spheroidal sequences of ref. 32, where \(T\) is the duration of the observed series. The Slepian sequences form a basis on which the data in

\[
\{x(0), x(1), x(2), \ldots, x(N-1)\}
\]

as the sum of a constant, a linear trend and a stationary time series specified only by its spectral representation

\[
x(t) = a_0 + a_1(t - t_0) + \epsilon(t); \quad t = 0, 1, \ldots, N - 1
\]

where \(t_0\) is a reference time, \(a_0\) and \(a_1\) are constants and the residual time series \(\epsilon(t)\) has the spectral representation

\[
e(t) = \int_{-N/2}^{N/2} e^{j2\pi f t} dX(f)
\]

for all \(t\). \(dX(f)\) is the differential of a generalized Fourier transform and is known as an 'orthogonal increment process'. (This is an extension of the representation used in ref. 25, where the \(CO_2\) series was decomposed into a trend, an annual component and a residual.) The annual component is given by the first moment of \(dX(f)\), and the power spectrum, or power spectral density, \(S(f)\), of the residuals is, by definition, the second moment of \(dX(f)\):

\[
S(f) = E[|dX(f)|^2]
\]

where \(E\) is the statistical expected-value operator. In a stationary series, values of \(dX(f)\) at distinct frequencies are uncorrelated.

Estimation

Although the time- and frequency-domain representations of time series are formally equivalent \(17\), we usually find it more informative to analyze time series in the frequency domain where the effects of different physical processes can be easier to distinguish. With short time series, such as the \(CO_2\) and global temperature records, it is difficult to resolve different frequencies and simultaneously obtain statistically significant results. Our approach is to use a variant of the multiple-window method of spectrum analysis \(18\) that, although it does not eliminate all the problems associated with short series, makes statistically efficient use of the available data.

Most frequency-domain methods are strictly valid only for the analysis of stationary data, not series with embedded trends such as the \(CO_2\) and global temperature records. Using the multiple window procedure described below, we estimate the trends in each series, subtract off these terms, and estimate the spectrum of the residuals. Finally, we test the residuals for stationarity to see if our assumptions were violated.

Estimating the average \(a_0\) and trend \(a_1\) by ordinary least squares can produce misleading results if the residuals \(\{\epsilon(t)\}_{0}^{N-1}\)
The coefficients of this expansion depend on frequency and are obtained by taking the discrete Fourier transform of the product of the data with each Slepian sequence. The lowest-order coefficient is similar to a direct spectrum estimate using a conventional data window or taper. A multiple-window estimate of the spectrum is, however, an adaptively weighted average of the \( 2BT \) frequency-dependent coefficients.

Because of their energy-concentration properties, the Slepian sequences are the data windows that are most resistant to spectral leakage. For example, the estimate of the temperature-series spectrum in Fig. 2b is produced using 11 Slepian sequences with \( 2B = 0.11 \) cycle yr\(^{-1} \); sidelobes of the effective spectral window shown in the insert are unobservable on the scale of Fig. 2a.

Choosing the parameter \( B \) for a multiple-window estimate of a spectrum involves a tradeoff between resolution and variance. The variance of this spectrum estimate is proportional to \( 1/(2BT) \). Thus, increasing \( B \) improves statistical reliability but decreases the resolution of the estimate.

### Trend estimates

To estimate the coefficients \( a_0 \), \( a_1 \), and \( a_2 \) in equation (1) by conventional time-domain regression, one minimizes the sum of the squares of the residuals \( e(t) \) with respect to the coefficients. Parseval's formula,

\[
\sum_{t=0}^{N-1} e^2(t) = \int_{-1/2}^{1/2} |F(f)|^2 \, df
\]

where \( F(f) \) is the discrete Fourier transform of the residuals \( e(t) \), so minimization in either the time or frequency domain is equivalent. To avoid the energy associated with the harmonics of the annual cycle and other high-frequency processes, however, we minimize only the integral over the low frequencies

\[
\int_{-W}^{W} |F(f)|^2 \, df; \quad W = BT/N < 1
\]

and ignore the higher-frequency components of the residuals, resulting in estimates expressible in terms of the Slepian sequences.

The multiple-window approach has several advantages when the residuals are autocorrelated. First, the 'observations' in the multiple-window regression are closer to independent Gaussian random variables than the original time-domain data \( \{x(t)\} \), and therefore the multiple-window coefficient estimates are closer to maximum-likelihood estimates than the estimates from ordinary least-squares analysis. Similarly, the number of degrees of freedom and error estimates are easily calculated using the Slepian sequences, and the multiple-window method is often more statistically efficient than ordinary least-squares analysis (C. Lindberg, manuscript in preparation). In conventional regression, the endpoints of the time series (for example, the abnormally high temperatures of the last decade) can have an inordinately large influence on the coefficient estimates.

This effect is largely eliminated in this approach. Finally, it is relatively easy to check the assumptions that have been made in representing the data by a particular model.

### Trends

For the monthly Keeling CO\(_2\) series (March 1958 to December 1988, \( T = 29.8 \) yr), estimates of the average and trend were obtained using \( r_{2BT} = 1975.0 \), and a bandwidth of \( 2B = 0.39 \) cycle yr\(^{-1} \). This value of \( B \) confines the spectral energy associated with the trend components to frequencies \( f \) with \( |f| < 0.195 \) cycle yr\(^{-1} \), avoiding energy associated with the annual cycle and its harmonics. This value of \( B \) also results in a spectrum that is locally white in the resolution band (at frequencies above 0.2 cycle yr\(^{-1} \), the CO\(_2\) residual spectrum drops rapidly, as shown below). The time–bandwidth product \( 2BT = 11.6 \) gives eleven leakage-resistant windows. The multiple-window procedure results in the estimates: \( a_0 = 331.7 \pm 0.44 \) p.p.m. and \( a_1 = 1.919 \pm 0.053 \) p.p.m. yr\(^{-1} \).

For the monthly Hansen–Lebedeff global temperature series from January 1880 to December 1988, we obtained estimates of the average and trend using \( r_{2BT} = 1934.5 \) and a resolution bandwidth of \( 2B = 0.128 \) cycle yr\(^{-1} \). This value of \( B \) was chosen to minimize the frequency band above the 0.07 cycle yr\(^{-1} \) where the residual global temperature spectrum decreases rapidly, as shown below. Using 12 Slepian sequences, we obtain \( a_0 = -0.106 \pm 0.030 \) °C and \( a_1 = 0.00554 \pm 0.00096 \) °C yr\(^{-1} \).

For comparison, estimates from ordinary least-squares analysis agree with the multiple-window estimates to three significant figures but, because of the lower values of the spectrum at higher frequencies, underestimate their standard deviations by a factor of five.

To assess the significance of this estimated global temperature trend, we note that Milankovitch theory predicts that at present the Earth should be cooling by \(-0.0004 \) °C yr\(^{-1} \) (refs 34, 35). Thus, solar variability aside, the null hypothesis is that the temperature trend should be slightly negative. To test this hypothesis we use a \( \tau \) statistic \( \tau = (0.00554 - (-4 \times 10^{-7})) / 0.00096 = 6.18 \) which, as 12 windows were used and two parameters were estimated, is characterized by approximately 10 degrees of freedom. Therefore, given that the low-frequency spectrum is approximately white (see Fig. 2b), the slope is greater than the Milankovitch prediction with probability 99.995% (ref. 36). Using a narrower bandwidth leads to fewer Slepian sequences with resistance to spectral leakage, fewer degrees of freedom and an underestimate of the slope significance. A wider bandwidth results in an invalid \( \tau \) statistic, as the residual spectrum decreases rapidly at frequencies \( >0.07 \) cycle yr\(^{-1} \) and so violates the 'locally white' assumption. Neither a jackknife variance estimate \( \hat{\sigma}^2 \) (a non-parametric statistic sensitive to both non-stationarity and non-stationarity, determined from the set of spectrum estimates computed with each of the windows deleted in turn), nor the stationarity test of ref. 38 show the residual series to be non-stationary. High-resolution quadratic inverse spectrum estimates provide some evidence for a ripple on the spectrum at frequencies \( >0.07 \) cycle yr\(^{-1} \), consistent with a 'recurrence time' in the temperature data of \( >300 \) yr, but the amplitude of this ripple is not enough to change the significance of the slope.

Finally, it has been argued that the temperature trend in the temperature record between 1940 and 1970 invalidates the conclusion that the temperature is increasing over the long term. To test this, we repeated the trend calculations for overlapping 30-year subsections of the Hansen–Lebedeff series. The estimated trends for each interval are shown as the short straight lines through the temperature record in Fig. 1, and the 95% confidence region of each is bounded by the hyperbolic arcs. The line associated with the linear trend of the entire temperature record remains in the corridor collectively outlined by the subsection error bounds.

### Spectrum estimates

We estimate the spectrum of the residual series \( e(t) \) by subtracting the periodic components (detected by a statistical F-test) from the detrended data, and by making an adaptively weighted multiple-window estimate of the power spectral density \( S(f) \) of the residuals. No frequency components above 2.5 cycle yr\(^{-1} \) are shown to avoid artefacts from the unequal lengths of the months.

Figure 2a is the low-frequency part of the spectrum estimate of the CO\(_2\) residuals using \( 2B = 0.39 \) cycle yr\(^{-1} \) and 11 windows. The spectrum is not white, so estimates using ordinary least-squares analysis of the CO\(_2\) trend error bounds are invalid. The variance of the estimate has been calculated by jackknifing over windows and, the resulting 5% and 95% confidence limits are shown. These error bounds are consistent with the
\( z \)-distributed estimate (with 22 degrees of freedom) expected from stationary gaussian data. Because of the shortness of this series, it is unlikely that details in the low-frequency end of the spectrum have been resolved; the plotted spectrum is a compromise between frequency resolution and statistical significance.

Figure 2b shows an estimated spectrum of the Hansen-Lebedeff global average temperature residual series. To allow resolution of more details in the spectrum, a bandwidth of \( 2B = \frac{0.11}{1} \) cycle yr\(^{-1}\) was used, resulting in 11 Slepian sequences

\[ 2B T = 108 \times 0.11 = 11.88. \]

As noted in ref. 21, this spectrum exhibits substantial power at periods near integer multiples of the annual cycle. Because the power is not a simple periodic signal in the data (recall that the Hansen-Lebedeff referencing procedure has already subtracted the annual cycle) we examine it further below.

**Relations between the series**

That both the CO\(_2\) and global temperature data have positive slopes does not prove that the two series are related. As the correlation in ref. 42 makes clear, each series has a climate influence, and the two series will cause simple time shifts. It is found, however, that the fluctuations of the two detrended series are coherent over a band of frequencies, then it is more likely that the two series are related.

The frequency-domain analogue of correlation, coherence\(^{27-44}\), has been applied to meteorological data for many years.\(^{46}\) Conventional sections of two records are the smoothed (by a moving average) complex product of the discrete Fourier transforms of the two series, and so can be badly biased if the phase changes over the frequency band. Section-averaging methods are inappropriate for short series; not only does dividing these series into subsections result in poor frequency resolution, but the correlation between the subsections produces unreliable coherence estimates. The multiple-window approach defined in refs 28 and 41 provides a less biased estimate of coherence \( C(f) \) which is suitable for short series, allowing the extraction of more information from the same data.

Figure 2b shows the multiple-window magnitude-square coherence between the Keeling CO\(_2\) and global temperature residuals from 1958 to 1988 (produced using the same bandwidth and number of windows as the spectrum estimate of the CO\(_2\) residuals). It is remarkable that the two series have a coherence above the 90% confidence level at frequencies \( <0.6 \) cycle yr\(^{-1}\), with coherence exceeding 98% over much of this low-frequency band. Because multiple-window coherence estimates spaced 2 \( \phi \) apart are essentially independent, the probability of observing such levels across a wide band is rare; chance dependence is very low, \( 2 \times 10^{-6} \). Thus, not only are the trend components (at frequencies \( >0.6 \) cycle yr\(^{-1}\)) of both time series increasing, but the residuals of the two series are also coherent with high confidence in the low-frequency band.

Figure 2b is a plot of the phase of the multiple-window coherence between the two residual (trend-subtracted) series. The phase of the coherence at 0 cycle yr\(^{-1}\) is zero and, because both trends are positive, is independent of whether trends are included or not. Between 0 and 0.6 cycle yr\(^{-1}\) the phase is roughly linear, corresponding to the CO\(_2\) series lagging the temperature series by \( \sim 5 \) months (calculated by taking the slope of the line). Between 0.6 and \( 1.5 \) cycle yr\(^{-1}\), the phase changes from positive to negative, with arguments that natural positive feedback mechanisms in the carbon cycle can cause carbon dioxide to lag temperature in some frequency bands.\(^{29}\) (R. Marston, personal communication.\(^{40}\)

Current knowledge of these complicated interactions involves solar forcing, the Southern Oscillation and exchange of CO\(_2\) with the oceans on various timescales, is summarized in section 6.6 of ref. 19. Also, in agreement with Keeling's hypotheses, the ocean processes are more important, we find that the coherence between the CO\(_2\) and the Southern Hemisphere average temperature records is slightly higher than that for the Northern Hemisphere and that the observed delay of \( \sim 5 \) months between the global temperature and CO\(_2\) is also seen in the Southern Hemisphere phase. As the Northern Hemisphere average temperature leads CO\(_2\) by \( \sim 3 \) months, part of the \( \sim 5 \) month delay may be due to the transport time from the Southern Hemisphere to Mauna Loa.

The hole in the phase curve near 1 cycle yr\(^{-1}\) occurs because the temperature spectrum there is dominated by a different
The coherence results presented here provide significant evidence that the average global temperature and CO₂ concentration from 1998 to 1999 are linearly related at these frequencies. But caution must be exercised in interpreting this result as suggesting that the variations in atmospheric CO₂ are causing the changes in global temperature, even though there are plausible physical mechanisms linking the two series. Apparent correlations that are used to postulate causality can sometimes be misleading, as in the case involving timing of volcanic eruptions. In addition, one should be particularly cautious in interpreting the coherence when the series analysed are as short as these; climatic and solar variations often are of longer duration than these records.

From atmospheric chemistry, global temperature depends nonlinearly on CO₂ concentration (T. Graedel, personal communication). The procedure used here implicitly uses a linear dependence. Bispectral estimates provide evidence of quadratic terms, although the shortness of these series makes this difficult to quantify. Also, except for the solar modulation of the temperature series near 1 cycle yr⁻¹, we have ignored the cyclostationary properties of these two series (that is, the statistics of these series vary periodically).

A more complete analysis would include estimates of the coherences between the various global average temperature time series, records of atmospheric CO₂ concentration, human CO₂ production, sunspot, volcanic activity and the Southern Oscillation Index, which are all high in various frequency bands and have complicated phase interactions. For example, the coherence between the defined Keeling CO₂ series and the Southern Oscillation Index is high near 0.4 and 2.4 cycle yr⁻¹. If we calculate the coherence between the CO₂ and global temperature series from which terms describing their linear dependences on the Southern Oscillation Index and sunspot record have been subtracted (called a partial coherence), the low-frequency magnitude-squared coherence increases to almost 0.7 whereas it decreases near 0.3 cycle yr⁻¹. Several of these series also exhibit an oscillation at an apparent period of ~15 years. Further analysis of their multivariate relations will be described elsewhere in more detail.
Environmental Geoscience: Interaction between Natural Systems and Man

Arthur N. Strahler
Alan H. Strahler
Atmosphere and Oceans

and follow with the solid earth, building up a resource bank from which many categories of information can later be drawn upon to understand complex environmental problems affecting the biosphere.

Introducing the Atmosphere

The earth's atmosphere consists of a mixture of various gases surrounding the earth to a height of many miles. Held to the earth by gravitational attraction, this envelope of air is densest at sea level and thins rapidly upward. Although almost all of the atmosphere (99%) lies within 18 mi (29 km) of the earth's surface, the upper limit of the atmosphere can be drawn approximately at a height of 6000 mi (10,000 km), a distance approaching the diameter of the earth itself.

From the earth's surface upward to an altitude of about 50 mi (80 km) the chemical composition of the atmosphere is highly uniform throughout in terms of the proportions of its component gases. The name homosphere has been applied to this lower, uniform layer, in contrast to the overlying heterosphere, which is nonuniform in an arrangement of spherical shells.

Pure, dry air of the homosphere consists largely of nitrogen (78.084% by volume) and oxygen (20.946%) (Figure 1.1). Nitrogen does not easily enter into chemical union with the other substances, but there are processes by which the gas is combined into nitrogen compounds vital to organic processes of the biosphere. In contrast to nitrogen, oxygen is highly active chemically and combines readily with other elements in the process of oxidation. Combustion of fuels represents a rapid form of oxidation, whereas certain forms of rock decay (weathering) represent very slow forms of oxidation.

The remaining 0.970% of the air is mostly argon (0.934%). Carbon dioxide, although constituting only about 0.033%, is a gas of great importance in atmospheric processes because of its ability to absorb heat and thus to allow the lower atmosphere to be warmed by heat radiation coming from the sun and from the earth's surface. Carbon dioxide is also an effective emitter of radiation and acts to cool the upper atmosphere.

Green plants, in the process of photosynthesis, utilize carbon dioxide from the atmosphere, converting it with water into carbohydrate. A pronounced rise in the carbon dioxide content of the atmosphere has been noted since 1800 and is a result of man's combustion of vast quantities of hydrocarbon fuels. This example of man's impact upon his environment is developed in Chapter 6. Cycles of replenishment and withdrawal of nitrogen, oxygen, and carbon (as carbon dioxide) from the atmosphere and ocean are explained in Chapter 19.

The remaining gases of the homosphere are neon, helium, krypton, xenon, hydrogen, methane, and nitrous oxide. Listed in decreasing order of percentage by volume. Altogether, these constituents total slightly less than 0.003% by volume. All of the component gases of the homosphere are perfectly diffused among one another, so as to give the pure, dry air a definite set of physical properties, just as if it were a single gas.
The Futility of Kyoto

What a surprise to find recognition at last in Patrick J. Caraher’s Sept. 26 Letter to the Editor, of water, not carbon dioxide, as the dominant “greenhouse” gas in the atmosphere. When you run the numbers, as I did for nine years teaching a course, “Air Pollution From Combustion Sources,” in the 1970s, the water averages out at 97% of the thermal trapping, with a top limit of 99%. With carbon dioxide as the balance of 1 to 3%. In other words, the carbon dioxide is less than the “noise” in the variations in the water.

What is now needed is recognition of the futility of trying to control global warming by reduction of carbon dioxide (the Kyoto Protocol Objective) by fuel switching or carbon sequestration, to say nothing of the economic damage by pointless diversion of resources to those ends. When can we expect this to penetrate the minds of the policy makers?

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I was concerned that the Soviets had been illuminating (“painting”) our satellites with their high-power laser at Sary Shagan. We had no comparable laser, except for MIRACL, being operated by the Navy as an Army “tenant” at White Sands, New Mexico. I felt it vital that MIRACL should be preserved in spite of budgetary pressures. Mr. Ike agreed, as did Gen. Abrahamson, with the proviso that other SDIO priorities not be harmed and that I not infer that my efforts were “officially” sanctioned. Not a career employee, I had a certain amount of freedom to “lobby” from outside the system, which I proceeded to do.

It was July 1988, and Tom Clancy’s novel “The Cardinal of the Kremlin,” with a strong laser theme, had just been published. I called Mr. Clancy and we mutually commiserated at the coming demise of MIRACL. I asked him for copies of his new book to send to government officials. He agreed, and put me in touch with publicist Suzanne Herz at Putnam’s; I asked her to send copies to Secretary of Defense Frank Carlucci, President Reagan’s deputy for National Security Affairs, Colin Powell, to William J. Crowe Jr., chairman of the Joint Chiefs, and to a few other policy makers. Ms. Herz was delighted to join the “conspiracy” to save MIRACL.

Rarely constrained by “the system,” I also lobbied in other quarters, and MIRACL was saved, possibly because of “The Cardinal” as much as the other efforts.

ARNOLD KRAMISH
Reston, Va.

(Mr. Kramish served on the Manhattan Project (atomic bomb) during World War II, as a member of the Atomic Energy Commission, the RAND Corporation and as a State Department science counselor. He was technical director of the Heritage/White House study resulting in the Strategic Defense Initiative.)

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Pepper . . . and Salt
CLIMATE, HISTORY AND THE MODERN WORLD

Second edition

H. H. Lamb

ROUTLEDGE
London and New York
THROUGH VIKING TIMES TO THE HIGH MIDDLE AGES

ASYMMETRY OF THE MEDIEVAL WARMTH OVER THE NORTHERN HEMISPHERE

As indicated in the last chapter, there seem to have been some regions of the world — particularly in low latitudes and in the Antarctic, possibly also around the north Pacific and in parts of the Arctic — where the rather greater warmth of the climate established around AD 300–400 continued, with variations but more or less unbroken, for several centuries longer and in some cases right through to AD 1000–1200. In Europe and much of North America, as well as in the European Arctic, there clearly was a break. But by the late tenth to twelfth centuries most of the world for which we have evidence seems to have been enjoying a renewal of warmth, which at times during those centuries may have approached the level of the warmest millennia of post-glacial times.

China and Japan evidently missed this warm phase. A warm period can be discerned in the historical records in those countries from about AD 650 to 850, more or less covering the time when Europe had its colder break. But in the eleventh and twelfth centuries the data collected by the late Dr Chu Kochen make it clear that the climate of China took a much colder turn, with frequent references to snow and ice in the winters and snows a month later in spring than in the present century. The plum trees were disappearing in north China; frosts killed the mandarin trees in the coastal province near Shanghai and the lychees in parts of the south. In Japan the long records of the dates of the cherry blossom in the royal gardens at Kyoto indicate on average the earliest springs in the ninth century and the latest springs of the whole record in the twelfth century, when the mean date was a fortnight later than it had been three hundred years earlier. There are hints that this was a cold time generally in and around the wide expanse of the North Pacific Ocean. If so, part of the explanation of the medieval warmth in Europe and North America, extending into the Arctic in the Atlantic sector and in at least a good deal of the continental sectors on either side, must be that there was a persistent tilt of the whole
circumpolar vortex (and of the climatic zones which it defines) away from the Atlantic and towards the Pacific sector, which was rather frequently affected by outbreaks of polar air.

In this chapter we shall concentrate our study on the Atlantic side of the hemisphere and the lands where the warmth of the high Middle Ages was most marked, since it happens that these are the areas where both the climatic and the human historical record are at present most accessible.

THE MEDIEVAL SEQUENCE IN NORTHERN EUROPE AND THE NORTHERN ATLANTIC

The reconstituted western empire of Charles the Great did not coincide with a particularly favourable climatic period. Nor did it last very long. The campaigns by which it was established between about 770 and 800 seem to have been in a time with more than usual tendency to cold winters; the other seasons, although perhaps more often dry than wet, revealed both drought years and some years when floods created difficulties. There is a suggestion in this that it may have been one of those times when 'blocking of the westerlies' by anticyclones in this or that longitude in 45-65° N was frequent, with a consequent disposition to extreme seasons of various, even opposite, sorts depending on where the stationary anticyclone lay: but further evidence is required before we can be sure of this.

Where there is no reasonable doubt is that over the next three to four centuries, as reports indicating the character of the seasons in Europe become more numerous, we see that the climate was warming up (cf. figs. 30 and 59), until there came a time when cultivation limits were higher on the hills than they have ever been since. Trees seem also to have been spreading back towards the heights. Certainly the upper tree line in parts of central Europe (cf. fig. 53) was 100-200 m higher than it became by the seventeenth century. The isotope record from the Greenland ice-sheet (fig. 36) shows us that the climate had already been in a relatively warm phase in the far north since AD 600, though the warmth there too was becoming more sustained and was increasing. On the heights in California the tree ring record (fig. 52) indicates that there was a sharp maximum of warmth, much as in Europe, between AD 1100 and 1300.

The variations shown by the more than one-thousand-years'-long record of the tree rings in European oaks from the lowlands of Germany are harder to interpret climatically, because both temperature and rainfall come into it. The records from different areas agree in producing the extreme narrowest and the extreme widest ring series both within the times covered by this chapter. The extremely narrow rings prevailing in the tenth century, especially between about 910 and 930 and again in the 990s, must surely indicate prolonged and repeated drought. One cannot suggest that any general coolness of the summers was responsible; the sparse documentary
VIKING TIMES TO THE HIGH MIDDLE AGES

Records point more to some of the summers being notably hot. The impression on present data is rather that the tenth century saw a remarkable amount of anticyclonic weather over Britain, Germany and southern Scandinavia, giving low rainfall, rather warm summers and rather cold winters. The latter point seems to be confirmed by the numerous bone skates revealed by the archaeological investigations in York from the Anglo-Scandinavian period in that city. The other extreme of the German oak chronologies occurred between about the years 1052 and 1160, when the decade average ring widths were 35–80 per cent wider than in the tenth century. We may deduce, if not excessive wetness (apart from isolated years), at least more moisture than in the 900s and general warmth of the growing seasons. Of this warmth we shall see further evidence in the following pages.

There is no mistaking the fact that there was a general opening out of the European world in the period we are considering in this chapter. How much of it was directly dependent on the more genial climatic regime which developed?

There had been European seafarers occasionally wandering out over the northern Atlantic long before Viking times. Prominent among them were Irish monks apparently seeking peaceful shores on which to establish a foothold far from the troubled times of cultural decay and barbarian migrations in Europe in the fifth and sixth centuries and after. It has been suggested that the annual migrations of the wild geese to and from Iceland and the Arctic gave them confidence that there was land to find in the north. One must suppose that there is some substratum of fact in the legendary voyage of St Brendan at some time between around AD 520 and 550 and that he got far enough in the direction of Greenland to encounter icebergs. Certainly Dicuil, an Irish monk writing AD 825, assures us that there are many other islands in the ocean... which can be reached in two days and two nights direct sailing from the northernmost parts of the British Isles with full sails and a fair wind... Some of these islands are very small... separated from one another by narrow sounds. On these islands hermits who have sailed from our Scotia [i.e. Ireland] have lived for about a hundred years. But, even as they have been... uninhabited from the world’s beginning, so now because of Norse pirates, they are empty of anchorites, but full of innumerable sheep and a great many different kinds of seafowl.

The islands here described are by general agreement the Faeroes, which were therefore settled by Irish monks as early as about AD 700–25. (I have used the translation given by Gwyn Jones in A History of the Vikings, Oxford University Press, 1968.) But they left around 800, when the Vikings first appeared. The Vikings’ first recorded exploration to Iceland (under Floki Vilgerdason) was not until about 860, though two earlier Scandinavian
voyages had been blown there accidentally a few years before. The Norse settlement on the island seems to have begun during the 860s. But they found that Irish monks had preceded them. Dicuil reports one visit as early as the 790s. The Irish account records that the sea was frozen one day's sail north from Iceland, and Floki's party observed one of the big fjords of northwest Iceland (Arnarfjord) choked with ice. But after that time there is little mention of ice — only brief and, according to Lauge Koch,\(^2\) doubtful reports of it in 1010–12, 1015, 1106, 1118 and 1145 — on the seas near Iceland until the 1190s, when it reappeared in some strength between Iceland and Greenland, and in July and August of the year 1203 it was at the coast of Iceland.

It seems likely that the beginning of the era of Scandinavian sea-going explorations, as of the rough story of Viking raids which harried the coasts of Europe from the 790s onwards, came with the mastery of sail by the northern peoples. Even then, they had no lodestone or compass until centuries later. But the spread of their voyages north into the Arctic and west to Greenland, and ultimately to Newfoundland and apparently into the Canadian Arctic north of Baffin Island, surely owed a great deal to the long period of retreat of the sea ice and probably a relative immunity from severe storms. Ottar, or Othere, whose home was in north Norway, told King Alfred in England of an exploration he had made about AD 870–80 beyond the customary range of the whalers of those days, evidently to the White Sea. And Harald Hardráđe who was king of Norway and England is reported by Adam of Bremen to have explored 'the expanse of the Northern Ocean' some time between 1040 and 1065 with a fleet of ships, beyond the limits of land (Spitsbergen or Novaya Zemlya?) to a point where he reached ice up to 3 m thick and 'there lay before their eyes at length the darksome bounds of a falling world'. The medieval Icelandic sailing directions covered voyages reckoned to take four days, north to Svalbard 'in the polar gulf', which it seems from the sailing time must have meant the east Greenland coast between 70 and 72 °N (not the Spitsbergen archipelago, to which the name is now applied). This coast was discovered in 1194; and seals, walrus and whales were hunted there already before the year 1200. Very soon, however, the increasing ice evidently put a stop to this, and the same coast seems to have been rediscovered in an easier year about 1285; but by 1342 the ice was so much increased that the old sailing route from Iceland to Greenland at the 65th parallel of latitude had to be abandoned for one farther south. Later, communication with Greenland was lost altogether.

The North American coast, Vinland (or Wineland) to the Norsemen, like Iceland and Greenland (where the first Norse settlement was established in the 980s) before it, was discovered by accident, by ships being blown off course, about AD 1000. The site of only one settlement, at L'Anse aux Meadows in northern Newfoundland, has so far been discovered.
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though another farther south is also referred to in the sagas. It seems, in any case, that the settlement and the America voyages were discontinued after a few years, and it appears that difficulties with the native inhabitants rather than weather or sea ice were the cause. Further accounts indicate that crossings from the Old Norse settlements in west Greenland to Markland (Labrador) were resumed much later, in the fourteenth century (one as late as 1347), when the climate and ice conditions had deteriorated and communications with Europe had almost ceased, to collect timber for building.

That the waters off west Greenland in the heyday of the Norse settlements were at least as warm as in the warmest periods of the present century is indicated by the abundance of cod which the inhabitants caught, the bones of which are found in their middens. We may probably safely conclude that an even greater warm anomaly occurred in the quiet waters within the fjords of southern Greenland west of Cape Farewell from another circumstance, a rare case where the limits of tolerance of man himself may yield reliable information on past temperatures. For it is recorded in the Landnámabók, a book written in Iceland about 1125 cataloguing the settlement of Iceland a couple of centuries earlier and describing the Old Norse settlement of Greenland between AD 985 and 1000, that one of the first Greenland settlers, Thorkel Farserk, a cousin of Erik the Red who founded the colony, having no serviceable boat at hand, swam out across Hvalseyjarfjord to fetch a full-grown sheep from the island of Hvalsey and carry it home to entertain his cousin. The distance was well over two miles.

Dr. L. G. C. E. Pugh of the Medical Research Laboratories, Hampstead, has given his opinion, from studies of the endurance of Channel swimmers and others undertaking similar exploits, that 10 °C would be about the lowest temperature at which a strong person, even if fat, not specially trained for long-distance swimming, could swim the distance mentioned. As the average temperatures in the fjords of that coast in August in modern times have seldom exceeded 6 °C (+3 to +6 °C being more typical), it seems that the water must have been at least 4 °C warmer than this limit in the year in which Thorkel swam it and brought home his sheep.

Other items point to a similarly great departure of the temperatures ashore in that area: for Old Norse burials took place deep in ground which has since been permanently frozen. It is harder, however, to be sure of the climatic implications of another report from the time of the old Greenland colony. Lauge Koch cites a medieval report that in 1188 or 1189 — i.e. at a time when the climate in the area may already have begun to be colder and the sea ice to reach somewhat farther down the coast towards south Greenland — a ship, the Stangfjorden, on passage from Norway to Iceland came to be wrecked off the east coast of Greenland. Some years later, about 1200, the dead bodies of seven of the ship's company were found in a rocky cave near that coast, among them the clergyman Ingemond who had
left a written report in runic letters on their fate beside him. Ingemond's brother, also wrecked about the same time, is reported to have succeeded, with two other men, in crossing the southern part of the inland ice, only to perish when near the main Norse settlement in Greenland, the so-called East Settlement (actually their southernmost settlement), a little west of Cape Farewell. This suggests that the inland ice in that neighbourhood was not thought of as such a hostile environment that one would not venture on it in an emergency, but nevertheless the going would be easier in the absence of melting and a crossing would doubtless require some days of reasonably good weather without strong winds.

By about AD 1250 the King's Mirror (Konungs Skuggja), a Norwegian work of that time, reports that

as soon as the great ocean has been traversed there is such a great superfluity of ice on the sea that nothing like it is known anywhere else in the whole world and it lies so far out from the land that there is no less than four or more days journey thereunto on the ice, but this ice lies more to the NE or N outside the land than to the S and SW or W.

A further passage about Greenland around 1250 in the same work reports that 'men have often tried to go up into the country and climb the highest mountains to look about and see whether there was any land free from ice and habitable'. A number of reports indicate that in this period of the early stages of the climatic deterioration the Norse Greenlanders were induced once more to roam more widely afield in search of food, including penetration farther north than before to the west of Greenland, reaching Baffin Bay and making contact with the Eskimos who were tending to move south.

Having to this extent taken the measure of the early medieval warm period at the limits of the Arctic region reached by the contemporary Europeans, let us now look at the evidence from other regions. The northern limits of the cultivation of grains show a corresponding expansion of range during the centuries with which this chapter is concerned. Grain was grown in Iceland from the time of the first Norse settlers there, apparently fairly continuously, until its abandonment in the late sixteenth century. There was also undoubtedly more scrub birch woodland there in the early days of the settlement than at any time since, though the settlers themselves seem to have been largely responsible for its destruction. Its area is believed to have been reduced from perhaps a fifth of the country to 1 per cent by the thirteenth century. Investigation by Dr G. S. Boulton, with colleagues from the University of East Anglia and from Iceland, of a farmhouse site at Kvisker in southeast Iceland that has been occupied for a thousand years revealed that the oldest of the successive houses on the site, dated before the volcanic ash layer of AD 1090, was the biggest and richest.
WORLD

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He, a Norwegian

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Fig. 62 One of the ancient farms, Svinafell, in southern Iceland, established in the earliest settlement times on a south slope. A great glacier can be seen now filling the valley close to the site of the farm. (Kindly supplied by Dr Sigurdur Thorarinson of Reykjavik and reproduced by permission.)

...is midden contained relics of diverse and luxurious foods, including (imported) oysters. And the forest surrounding the farmed land there produced birch stumps of a good size, never attained since. From pollen analysis... AD 1200 and reduced the amount of barley grown by about a half. In the next century much of the ground was covered by river gravels and part of it by a glacier (see fig. 62).

THE PEAK OF MEDIEVAL WARMTH IN EUROPE

In Norway some kind of corn, probably barley, was grown as far north as Malangen (69° N) in north Norway, at least from Otakar's time (around 880) until the eleventh century, and wheat in Trondelag, the district about Trondheim, where pollen studies and other records again indicate that it came to an end sharply in the later Middle Ages. Professor Andreas Holmsgen reports that it was just between about AD 800 and 1000 that the area of forest clearance and settled farming in Norway which had long remained more or less static, spread 100–200 m farther up the valleys and on to the higher ground. Most of this ground was lost again after AD 1300.
Fig. 63 Relics (ridge and furrow) of medieval tilled fields between 350 and 400 m (1150–1300 ft) above sea level on the heights of Dartmoor in southwest England beside the abandoned settlement of Houndtor which lies just to the left of the picture. The Greator rocks are seen in the picture. (Photograph, copyright by G. Beresford, who kindly supplied it for this book.)

Fig. 64 Ridge and furrow, the result of thirteenth-century tillage, seen on the fells on a south-facing slope above Redesdale, Northumberland at 300–320 m above sea level.
In many parts of Britain, also, the tillage extended to greater heights than for some long time previously or since. At Dunmoor in the southwest (Fig. 63), in about 400 m (1300 ft) and in Northumberlond, near the Scottish border (Fig. 64), at 320 m (1050 ft) above sea level belonging to Kildonan Abbey, the vineyards were probably between 0.7 and 1.1°C warmer than the twelfth-century average in England and 1.0-1.4°C warmer in central Europe. In the present climate, the vineyards in England. The comparison indicates that the average summer temperatures used in Fig. 30 and even the figures derived from the method of the summer of the year were about 0.5°C warmer (Fig. 84-5). The vineyards along the south of Scotland had over 100 hectares of vineyards along the south of England, and even in central Europe. The approximate range of the vineyards in central Europe. The quality of the vineyards along the south of England, and even in central Europe. The quality of the vineyards along the south of Scotland had over 100 hectares of vineyards along the south of England, and even in central Europe.
Fig. 66 The medieval English vineyard site at Tewkesbury, Gloucestershire. The ground slopes gently northwards to a ditch in the middle ground of the picture. Surely a frost hollow site, which suggests that the medieval cultivators were not much troubled with late frosts in May after blossom time.

of the English medieval wine is indicated by the efforts of the French trade at that time to have them closed down (under a treaty). In England particularly it seems that there must have been less liability to frost in May in the period between 1100 and 1300. (Fig. 66 is interesting in this connection.)

Thus, it seems that the great period of building of cathedrals in the Middle Ages, in what Kenneth Clark has called the first great awakening in European civilization, and the sustained outburst of energy of the European peoples, which produced among other things the more controversial activities of the Crusades, coincided with an identifiable maximum of warmth of the climate in Europe. Hugh Trevor-Roper makes no comment on the climate but notes the time around AD 1250 as the turning point:

the highest point of the European Middle Ages. . . . Up to that date we see— from about 1050 onwards— only advance . . . growth of population, agricultural revolution, technological advance. The frontiers are pushed forward in all directions. . . . Already in the middle of the thirteenth century the territorial expansion had been halted . . . in 1242 the eastward advance of the Teutonic knights . . . was
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... held up by the ruler of the Russian Slavs. ... By 1300 all that remained of the Eastern Empire of Christendom was a few shrinking relics of Greece.

The warm phase, which had already passed its peak in Greenland in the twelfth century, seems to have broadly continued in Europe until 1300 or 1310 though with a marked increase in the incidence of severe storms in the North Sea and the Channel and with flooding disasters on the low-lying coasts. The warmth may even have reached its maximum at this late stage: for there are documentary records to tell us that it was in the 1280s that the tillage reached so high on the Pennines and Northumbrian moors that there were complaints from the sheep farmers that too little land was left for grazing. Such a peak of warmth in the last stages before Europe itself was affected by the down-turn of the Arctic would be meteorologically consistent with the development of a strong thrust forward of the Arctic regime in the high latitudes of Greenland and Iceland, distorting the pattern of the circumpolar vortex with a sharp trough there and a recurrent warm ridge over western Europe. Something like this pattern seems to have recurred at times in the middle and later parts of the fourteenth century, bringing notable droughts in Europe after an extremely wet phase which had marked the first break in the early part of that century. (It is likely that some of the troubles about this time with the massive buildings—cathedrals, churches and castles, with collapsing towers and cracking walls and arches (fig. 67)—were not so much due to faults of design as to soil moisture changes and consequent setting.)

The occurrence in medieval York of the bug *Heterogaster urticae* (E.), whose typical habitat today is on stinging nettles in sunny locations in the south of England, discovered by the city of York archaeological investigations to have been present there both in the Middle Ages and in Roman times, presumably indicates prevailing temperatures higher than today's. Another implication from insect studies is the abundance also in medieval York of a beetle *Agelenus brunnneus* (Gyll.) whose habitat preferences indicate high temperatures generated in decaying vegetable refuse. Both these discoveries hint at rather high prevailing temperature of the urban environment itself in the tightly built-up medieval city centre.

There are many indications that in eastern Europe, as in Greenland and Iceland, a colder, more disturbed climate set in already in the 1200s. And, indeed, as far west as the Alps, some trouble was caused by advancing glaciers during the thirteenth century. During some part of the warmest period, perhaps in the tenth and early eleventh centuries, there seems to have been concern about drought in the Alps: for a water supply duct, the Obermaderin, was laid from high up near the Aletsch glacier to the valley below, and similar water supply installations were engineered in the Saasal...
Fig. 67 An arch deformed by subsidence in Carlisle Cathedral. No movement seems to have occurred after about 1300–50. Compaction of the site through drying out of the soil in the previous centuries has been suspected as the cause of the damage seen (see pp. 197–8).

(Also in Switzerland) and in the Dolomites, only to be overwhelmed by the advancing glaciers between 1200 and 1350.

The ancient gold-mines in the Hohe Tauern in Austria and other high-level mines in central Europe, abandoned before the time of Christ, were opened up and worked again in the warmth of the high Middle Ages, only to be abandoned again later. Underground water began to cause difficulties about 1300: at Goslar it was reported in 1360 that water had been increasing in the mines in the Harz Mountains for more than fifty years. In Bohemia the same difficulty led to some mines being abandoned as early as 1321. In the Alps some of the mine entrances were again closed by the glaciers.

THE CONTEMPORARY SCENE IN THE MEDITERRANEAN, EASTERN EUROPE AND ASIA

In the Mediterranean, as also in the region of the Caspian Sea and on into central Asia, the period of warmth in high latitudes in the Middle Ages seems to have been a time of greater moisture than the present century. Lake levels were high, the Caspian Sea as much as 8 m above its present level during much of the time between the ninth and fourteenth centuries.
Fig. 68 (a) The medieval bridge (Ponte dell'Amministrazione - Bridge of the Admiral) at Palermo, Sicily, built in 1113 to span a much larger river than now exists there. The River Otranto, which has now been diverted, as seen in (b), was used by ships up to this bridge when it was first built. (Photographs kindly supplied by General Fea of the Servizio Meteorologico, Aeronautica Militare Italiana, Rome.)
CLIMATE, HISTORY AND THE MODERN WORLD

Two of the rivers of Sicily, the Erminio and the San Leonardo, were described as navigable in the twelfth century — something which would now be impossible even for the vessels of those times. Bridges were built, as across the Orento at Palermo in Sicily (fig. 68), of a size not required by the present rivers. (The famous Pont d’Avignon finally built across the lower Rhone in southern France in 1177-85 at a difficult point, where roads converge but the current is always strong and the Romans had been unable to bridge the river, suffered many collapses of parts of the bridge in the following years but was not finally abandoned until destroyed until 1680.) There was also in the high Middle Ages more general flow of the streams in Greece and in the wadis of north Africa and Arabia. Fig. 45 (p. 131) indicates a more adequate rainfall in medieval times also in the dry area of northwest India.

These features seem likely to be explained partly by a displacement of the anticyclone belt of the desert zone during the warm epoch north of its present usual position to an axis from the Azores to Germany or Scandinavia as in some of our modern fine summers. Such partly meridional wind circulation patterns, with a cold trough deformation of the circumpolar vortex, commonly thrust cold surface air south over eastern Europe and western or even central Asia, and from there it would be deflected by the mountains westward and southward towards the Mediterranean. This is an eastern position for such a development in the circumpolar vortex, requiring a longer wave-length (or spacing of the troughs and ridges) than commonly prevails in the upper wind flow from the more or less fixed disturbances over North America caused by the Rocky Mountains. Such a longer wave-length would be likely to occur at a time when the main flow of the winds was displaced towards higher latitudes and particularly when, as in the thirteenth century, Arctic cooling strengthened the thermal gradient and the winds.

Our knowledge of the past variations of lake levels — archaeologically determined in the case of the Caspian Sea — indicates that the barbarian movements out of Asia which troubled the Roman empire over a long period can be associated with times of drought in central and western Asia around AD 300, which also returned around 800. By contrast, the great outbreak of Mongolian tribesmen in the thirteenth century seems to have occurred in a moist period, when the Caspian Sea was rising. The sudden outburst of energy of the peoples of inner Asia, which brought Genghis Khan and his Mongol horde within the space of twenty years, between 1205 and 1225, deep into European Russia, to the Indus and to the gates of Peking, could reasonably be supposed to have had its origin in a build-up of population in the arid heart of Asia in times when the pastures were in better than usual shape. But its suddenness, and the coincidence of its timing with what we know of the cooling in high latitudes from the isotope record in northern Greenland and the great advance of the Arctic sea ice towards Iceland, raises a suspicion that some more sudden event connected
with the cooling may have triggered it off. This could have been some invasion of the heart of Asia by colder Arctic air than before, the effects of which would be particularly noticeable if it happened in summer. This is speculation, but China had long been experiencing a cold regime and some scientists have thought that this anomaly gradually spread westwards until it enveloped Europe in the Little Ice Age of later centuries.

There was clearly some difference between the sectors of the northern hemisphere with which these paragraphs have been concerned and the situation over east Asia, where the climatic zones seem to have been pushed south over a long period of which the twelfth century marked the climax. The swing to the southeast of the isotherms and of the flow lines of the circumpolar vortex from a northward displacement (or ridge) over the Indian sector to a southward displacement (or trough) over east Asia is a pattern which seems liable to have introduced an anticycloonic tendency over Thailand and northern Indo-China, reducing rainfall there. This meteorological speculation suggests an explanation of temporarily easier — i.e. drier — conditions favouring the Khmer empire of Angkor in Cambodia (Kampuchea) in the region, which after 1300 returned to jungle.

EFFECTS ON SEA LEVEL AND LOW-LYING COASTS

Our survey of the European scene during the warmer centuries of the Middle Ages would not be complete without mention of the things that suggest a slightly higher stand of the sea level, which may have been gradually rising globally during that warm time as glaciers melted — and particularly in the area around the southern North Sea where the land-sinking due to the folding of the Earth’s crust was presumably going on then as now. Fig. 60 draws attention to the greater intrusions of the sea in Belgium, where Brugge (Bruges) was a major port, and in East Anglia, where a shallow fjord with several branches led inland toward Norwich. The English fenland south of the Wash provided an extensive watery landscape of shallow brackish channels and low islands, fringed by reeds and brushwood, in which the island of Ely was so cut off that the Anglo-Danish inhabitants were able to hold out for seven to ten years after the Norman conquest of the rest of England. And the coastal plain of the Netherlands and Belgium had a fluctuating population in the eleventh and twelfth centuries, as the state of flooding varied, leading finally to a more general emigration to Germany.6

THE SEQUENCE IN NORTH AMERICA AND SOME COMPARISONS

In North America east of the Rocky Mountains there is evidence that the prevailing temperatures followed a sequence very similar to that in Europe
CLIMATE, HISTORY AND THE MODERN WORLD

and that there were interesting and important changes in the moisture climate. Only in northern Labrador and the neighbouring Ungava region is there any sign so far of a medieval interruption in the cooling off that began 3000–3500 years ago and put the forest into retreat before the advancing tundra. In northern Quebec and in the North-West Territories west of Hudson Bay, the extensive pollen-analytical researches co-ordinated by Dr Harvey Nichols of the University of Colorado Institute of Arctic and Alpine Research indicate some recovery of the forest, associated with warming of the summers, from about AD 1500 to some time about 1000–1200 or 1250. Farther south, in the Middle West of the United States, the archaeological studies of Baerreis and Bryson at the University of Wisconsin have indicated that the Indian people of the Mill Creek culture grew corn (maize) in northwestern Iowa before the year 1200, in an area which today is somewhat marginal as regards enough rainfall for the crop. Elk and deer, both woodland animals, which they evidently hunted, together accounted for most of the flesh in their diet before about 1100; in the twelfth century the proportion of these among the bones in the middens rapidly declined and was overtaken by bison, an animal of the open plains. The abundance of bison bones increased towards the west where the climates are drier, in the ‘rain-shadow’ of the Rocky Mountains. But from about AD 700 onwards the climates of the whole region seem to have become moister than before, the prairie giving way to landscapes with more trees, until an abrupt reversal about the year 1200. Farming peoples were spreading their occupation northward on the plains, moving northward into Wisconsin and on up the Mississippi and other valleys into Minnesota as early as the eighth century. They maintained a thriving culture until 1200, when their sudden disappearance coincides with evidence of drought and vegetation change. Such a change in the region concerned is readily explained by increased sway of the westerly winds, intensifying and extending the rain-shadow of the mountains, as the thermal gradient increased with the cooling of the Arctic then setting in. We have referred to the evidence of this on Greenland and Iceland waters.

The climatic history reviewed in this chapter has led one historian to summarize the matter by saying: ‘intriguingly, the profile of long-run average temperature in England shows a crude but clear congruence with that of material welfare broadly conceived’. And he goes on ‘The medieval expansion, the crises of the fourteenth and late sixteenth centuries, and the revivals of the fifteenth (to early sixteenth), eighteenth and nineteenth centuries, broadly correspond with movements in the trend line of temperature.’ Yet, he argues that climatic change has little explanatory value and that one cannot assert that the course of European history would have been much different if the climate had not changed. The period covered by the next chapter will give us an opportunity to examine this contention a little more closely.

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DECLINE AGAIN IN THE LATE MIDDLE AGES

THE DOWN-TURN OF CLIMATE IN THE ARCTIC

The deterioration in their situation which announced itself to the Old Norse Greenlanders in 1197–1203 by the increase of ice encroaching on the seas that were used for their links with Iceland and with Europe, at first in occasional years but later on seeming permanent, clearly had to do with a cooling of the Arctic (see fig. 36, p. 93).

Already during the twelfth century the Eskimos of the Dorset culture, once (about 700 BC) widespread across the eastern Canadian Arctic, who had returned to high latitudes after AD 800–900, had been moving south. Archaeology suggests that this was partly because another Eskimo culture, developed near Thule in northwest Greenland, was more successful in hunting the resources of the far north; but it is probable also that increasing ice and dwindling seal and walrus populations were making the competition more difficult. And so it was around 1200–50 that Norsemen and Eskimos first came into contact in Greenland. At first some trading went on between them. But about 1350 the smaller of the two Norse centres in Greenland, with only about seventy-five farms, the Vesterbygd ("West Settlement"), which was the more northerly of the two areas occupied in west Greenland, was wiped out either by conflict or disease, possibly the plague. (Some cattle and sheep were found wandering unattended by any human owners when a ship visited the area from the other settlement.)

The larger Østerbygd ("East Settlement"), where there were about 225 farms, survived until about the year 1500, though in evident decline: the average stature of the grown-up men buried in the graveyard at Herjolfnes in the fifteenth century was only 164 cm (5 ft 5 in.) compared with about 177 cm (5 ft 10 in.) in the early period of the settlement. By about 1342 it is recorded that the old sailing route along the 65th parallel of latitude between Iceland and Greenland was finally changed to a route farther south because of the increase of ice. After the wreck off Norway of one of the ships used in the late medieval royal monopoly trade in 1369 regular communication between Europe and the Greenland colony ceased. Some
CLIMATE, HISTORY AND THE MODERN WORLD

ships bound for Iceland arrived in Greenland in later years after being blown off course, and there is indirect evidence of occasional visits by traders and freebooters from England and elsewhere in the fifteenth century. In 1492 Pope Alexander VI wrote of his anxiety over the situation in that outpost of Christendom:

the church of Garda is situated at the ends of the Earth in Greenland, and the people dwelling there are accustomed to live on dried fish and milk for lack of bread, wine and oil... shipping to that country is very infrequent because of the excessive freezing of the waters—no ship having put in to shore, it is believed, for eighty years—or, if voyages happened to be made, it could have been, it is thought, only in the month of August... and it is also said that no bishop or priest has been in residence for eighty years or thereabouts.¹

In fact, the Herjolfnes graveyard preserved bodies and clothing in the subsequently permanently frozen ground, the dresses including European models of about the year 1500. But ships from Hamburg beaten off course to Greenland about 1540 found only one dead Norse body and no inhabitants alive. From that time on only whalers, or explorers such as Hudson in 1607, occasionally happened to get through the ice belt to this or that point on Greenland's deserted Arctic shores, until in the 1720s the Danish-Norwegian state once more founded posts, again in southwest Greenland. There were no settlements in east Greenland before the nineteenth century.

-- It has been suggested that the explorations in the fifteenth century which led the fishermen from Bristol ever farther west across the Atlantic, until as early as the 1470s or 1480s they may have fishing on the Newfoundland Banks,² may have started because the fish stocks of the higher latitudes in the northeast Atlantic had deserted their former grounds as a result of the increasing spread of the Arctic cold water. The situation was doubtless aggravated by Hanseatic competition in Iceland-Greenland waters. However that may be, it is clear that the searches of the English sixteenth-century seafarers such as Chancellor in 1553 and the Dutch expedition under Willem Barents in the 1590s to find a North-East Passage, and of Frobisher in the 1570s, of Davis in the 1580s and soon Hudson, to find a North-West Passage through the Arctic to the Indies were undertaken at a peculiarly unfavourable time. The same was true of Hudson's attempt in 1607 to reach the North Pole and still in 1827 of Edward Parry's attempt, and of the renewed efforts around that time to seek out a North-West Passage, as well as the voyage of Sir James Clark Ross in 1831, which succeeded in reaching the north magnetic pole.³ The severer Arctic climate had then ruled for hundreds of years, though there were still some openings in the polar pack-ice controlled by the wind pattern; the whalers had found some of these in their operations near northeast Greenland, and this
DEcline in the late middle ages

had produced a misplaced belief in the existence of an ice-free sea in the central Arctic.

In Iceland the old Norse society and its economy suffered a severe decline which set in first about AD 1200 and could be said to have continued over almost six centuries. The population of the country fell from about 77,500, as indicated by the tax records in 1095, to around 72,000 in 1311. By 1703 it was nearly down to 50,000, and after some severe years of ice and volcanic eruptions in the 1780s it was only about 38,000. The people's average stature also seems to have declined, much as in Greenland, from 175 cm (5 ft 8 in.) to 167 cm (5 ft 6 in.) from the tenth to the eighteenth century. It is clear from the surviving records that years when the Arctic sea ice was close to the Iceland coast for long months (usually between January or March and any time from June to August) played a big part in this. In such years the spring and summer were so cold that there was little hay and thousands of sheep died, especially all over the northern and eastern part of the country. The shellfish of the seashore were also destroyed by the ice. Gradually all attempts at grain growing were given up. The glaciers were advancing. And there were some volcanic disasters besides, when whole areas of the island were covered by volcanic ash or lava flows, the pastures were ruined by the fluorine or sulphurous content of the ash and the sheep and cattle were killed by it. One of the worst cases was the great eruption in Óræf in the south of Iceland in 1362.

It cannot be denied that the trade monopoly claimed by the Danish-Norwegian crown through most of these centuries must also have had some effect, its restrictions probably contributing to the country's difficulties, but it seems that the main causes of decline were the natural disasters — Iceland's 'thousand years struggle against ice and fire', as Sigurdur Thorarinsson's 1956 article called it.

That there were some easier times as well as periods of great severity during these centuries can be clearly discerned despite the scarcity of records at certain times. For example, the widespread use of polar bear skins in the late Middle Ages for carpeting the church floors in Iceland indicates a large supply of the bears, and therefore presumably of the ice which brought them, in the fourteenth century. A hundred years later the skins were getting scarce, and many were old and in poor condition, but there was some increase in the sixteenth century before this item became restricted by the trade monopoly of the monarchy in Denmark. This information seems to confirm the inference from the direct reports of the sea ice which survive that there was much ice from the late 1200s through the fourteenth century, and then some improvement before the drastic increase of ice in the late 1500s and after. The times of most ice and coldest climate in Iceland seem to have started suddenly in 1197–8 and 1203 and reached culminating phases around 1300, from about 1580 to 1700, especially the 1690s, and again in the late eighteenth and nineteenth centuries.
Fig. 69 Two pictures of North Sea storm waves assailing the sea defences of the small island of Heligoland in a northerly storm, Beaufort force 10, on 10 October 1926. The island is but a remnant of its former size. (Photographs F. A. Schensky, reproduced by kind permission of his daughter Miss L. Schensky of Schleswig.)
DECLINE IN THE LATE MIDDLE AGES

HOW EUROPE WAS FIRST AFFECTED: STORMS

The first symptoms of the change already affecting Greenland and Iceland, which may have been noticed by the inhabitants of Europe, particularly around the North Sea, were the increased incidence and severity of wind storms and sea floods in the thirteenth century. Some of the latter caused appalling loss of life, comparable with the worst disasters in Bangladesh and China in recent times. In at least four sea floods of the Dutch and German coasts in the thirteenth century the death roll was estimated at around 100,000 or more; in the worst case the estimate was 306,000. As a result of the floods of 1240 and 1362 it was reported that sixty parishes accounting for over half the agricultural income of the (at that time) Danish diocese of Slesvig (Schleswig) had been 'swallowed by the salt sea'. In some of these storm floods the Zuyder Zee in the Netherlands was formed, and enlarged, and it was not drained until the present century. Islands, and other inlets, were formed by losses of land on the German and Danish North Sea coasts. Other islands were destroyed by the stormy seas. The island of Heligoland (50 km out in the German Bight), which is believed to have measured over 60 km across in the year 800, had been reduced to 25 km by about 1300, perhaps half of it being lost in a storm in that year. Today it measures only about 1.5 km on its longest axis (fig. 69). In England the great ports of Ravenspur or Ravensburgh (east of Hull) and Dunwich (on the Suffolk coast in East Anglia) were lost in successive stages in the sea storms of these centuries. Deaths of 100,000 or more people in floodings of the continental shore of the North Sea were again reported in storms in 1421, 1446 and 1570. In the 1570 storm great cities were flooded, and

![Number of reported severe sea floods per century](image)

**Fig. 70** The distribution by centuries of reports of severe storm floods which caused much loss of life or land on the coasts of the North Sea and English Channel. The data and sources of data on which this diagram is based are fully tabulated in the author's book *Climate: Present, Past and Future*, vol. 2, London, Methuen, 1977, pp. 120–6. Any apparent mistakes by earlier collectors of the data from the distant past producing repetitive reports of the same incident have been cut out in the counts of numbers of storms for this diagram.
Fig. 71 Some results of the storms of blowing sand in the late Middle Ages:
(a) (top) The lagoon at Kenfig on the coast of south Wales, near Port Talbot, formed by sand-dune movements, reputedly around 1316, which closed the medieval port there. Further movements between 1344 and 1480 finally buried the old Roman coast road and with a storm in 1573 carried a line of high sand-dunes 3 km inland.
(b) The coast edged with a belt of great sand-dunes protecting the flatland of Morfa Harlech in northwest Wales. These dunes lie more than 1 km seaward of the former port of Harlech, in use until about 1385, which they closed.
the deaths were estimated at 400,000. And in 1634 there were again great losses of land from the Danish and German coast and the off-lying islands.

Fig. 70 shows the distribution over historical time of known reports of severe sea floods in this part of the world. In the southern North Sea on the Netherlands coast the occurrence of devastating storm surges was greatest in the early 1400s and late 1600s; the late 1500s were remarkable for a few storms of outstanding range and severity, most of all the storm of 1–2 November 1570 when the flooding affected the coasts from France to northwest Germany. In reading the diagram allowance must be made for the reduced chance of reports having been made and surviving from early times, but it seems safe to conclude that there were real maxima of storm flood occurrences for the region as a whole in the eleventh and in the thirteenth centuries AD, and in the southern North Sea at the times mentioned above. There is also a suggestion of more severe floods in, and soon after, late Roman times and again in our own century than at other periods. This distribution suggests that storm floods on the low-lying coasts of the North Sea have been most troublesome: (a) when the sea level may have been somewhat raised after long periods of warm climate and glacier melting; and (b) when a cooling Arctic has produced a strengthened thermal
CLIMATE, HISTORY AND THE MODERN WORLD

gradient in latitudes between about 50 and 65°N, leading to increased storm frequency and severity over this zone. In the thirteenth century, and perhaps again in recent decades, both these conditions were present. One must conclude from the much more restricted range and loss of life in modern storms that the dykes which have been built along the coasts of the North Sea, and continually improved, in later centuries are among man's greatest successes in defence against natural disasters.

Another accompaniment of some of the severe storms of the northeast Atlantic and North Sea region in the late Middle Ages and after was the overwhelming of a number of coastal places by blown sand (fig. 71). There was a long epidemic of such disasters on the sandy coasts of northwest Europe from Brittany to the Hebrides and Denmark, starting about the thirteenth century and continuing to about 1800. As examples, the little medieval port of Harlech on the west coast of Wales was permanently obliterated by a line of great sand dunes around 1400, within at most a few decades of the other cases pictured in fig. 71. In the seventeenth century a great storm destroyed the fine natural harbour at Saksun on the northwest side of the Faeroe Islands by filling it with sand, and another overwhelmed an area—now known as the Cublin Sands—of perhaps 60 km² of fine farmland, including nine farms and a mansion house, in northeast Scotland. In the sandy terrain of the Breckland in East Anglia and in similar country in the Netherlands even places inland were affected by frequent blowing sand in this period.

It is interesting that the case pictured in fig. 71c on the east coast of northern Scotland took place with a southerly storm, a circumstance which lowers the level of water in the North Sea. Moreover, the date reported was within a few days of a date when the astronomically calculated tide was only 4–7 cm short of the extreme of the nineteen-year cycle, and this was itself only one cycle short of a roughly 2000-year extreme. This coincidence may point to a combination of factors which led to the shifting of so much sand as to destroy a coastal township in a single severe storm. An exceptionally low tide seems likely to have occurred, laying bare a wholly abnormal expanse of sand to be scoured by the wind. It is, of course, possible that previous storms and high tides had played a part in preparing the situation through moving sand towards the shore by wave action and leaving uneven accumulations of it. At all events it is noteworthy that the epochs of widespread sand-dune activity on northwest Europe's coasts both in the last millennium before Christ and in the late Middle Ages were not only times of relatively cold, or cooling, stormy climate in this latitude but were also more or less centred around long-term maxima of the range of the tides.

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Cooling and Wetness in Early Fourteenth-Century Europe

The cooling trend, which should be seen as the basic element in the climatic deterioration with which this chapter is concerned, began to affect Europe directly soon after 1300. The generalized temperature curve presented in fig. 30 (p. 84) seems to be verified by the history of the vineyards in England and central Europe and of the upper limit of trees on the hills from the Vosges in the west to the Erzgebirge on the borders of Czechoslovakia, Germany and Poland. This smooth curve, however, masks the real shocks.

The change which broke the medieval warm regime must have appeared devastatingly sudden. It came first in the regions mentioned with the extraordinary run of wet summers, and mostly wet springs and autumns, between 1313 or 1314 and 1317. And it continued with little intermission at least to the early part of 1321. Moreover, this followed closely upon one of the really notable periods in the Middle Ages of mostly warm, dry summers, from 1284 up to 1311. (The first decade of the new century was a time when many had the confidence to start new vineyards in England.) The year 1315 (see fig. 72a), when the grain failed to ripen all across Europe, was probably the worst of the evil sequence which followed. The cumulative effect produced famine in many parts of the continent so dire that there were deaths from hunger and disease on a very great scale, and incidences of cannibalism were reported even in the countries of western Europe. Great numbers of sheep and cattle also died in the 'murrains' or epidemics of disease which swept the sodden and often flooded landscape.

Thereafter the fourteenth century seems to have brought wild, and rather long-lasting, variations of weather in western and central Europe, the later 1320s and 1330s and also the 1380s with mostly warm, dry (often seriously droughty) summers and a few other decades, notably the 1360s, predominantly wet. In eastern Europe there seem to have been troubles with heat and drought in the summers throughout the century. The type of variability of the climate in western Europe here described, which affected the winters also, continued in the fifteenth century and spread to eastern Europe as well. The 1430s produced a very remarkable sequence of severe winters or winters which at least included long severe spells, in central and western Europe, including 1431-2 (fig. 72b) and every winter from 1433-4 to 1437-8. Within the last thousand years only the 1690s seem to have produced so many cold winters or severe spells within the span of one decade. Furthermore, the winters of 1407-8 and 1422-3 had been of historic severity, permitting traffic over the ice across the Baltic and with wolves reported to have passed over the ice on the easternmost part of the North Sea from Norway to Denmark.

A graphical 'history' of the wetness of the Bolton Fell Moss peat-bog on the England-Scotland border near Carlisle, produced by a variety of
Fig. 72b Reported weather in the winter of 1431-2 and the prevailing pressure and wind pattern which seems to be implied.

researches, is shown in fig. 73. This seems to agree with the temperature and rainfall sequences presented elsewhere in this book and therefore may be regarded as supporting evidence of them. (There is an apparent discrepancy in the wetness indicated in the tenth century, but wetness in the northwest corner of England could be consistent with the pattern we have supposed at that time with westerly winds there and anticyclonic situations producing droughts in the southeastern half of England and in Germany.)

The Bolton Moss curve certainly supports Trevelyan's contention that the rivers of England were generally deeper and bigger in the fifteenth century than they are now (and, perhaps, earlier in the high Middle Ages). What is abundantly clear from fig. 73 is that there was a very great change in the prevalence of soil moisture, at least in northwest England, about 1300. The change seems in fact to have occurred much more widely, in view of
Fig 73 The record of long-term variations of the surface wetness of Bolton Fell Moss peat-bog northeast of Carlisle, derived by Dr Keith Barber of Southampton University (from pollen and macrofossil analysis, soil chemistry investigations and records of land-use history). (From data kindly supplied by Dr Barber.)

the frequency of regrowth phases reported in the peat-bogs of Sweden and elsewhere in northern and western Europe about this date. Corresponding difficulties, caused by increasing wetness, were noted in the last chapter in the mines in the Harz and other mountains in central Europe.

Perhaps the most remarkable aspect, devastating in all its effects, of European climates in most of the decades studied in the fourteenth and fifteenth centuries AD was the extraordinary frequency of easterly winds which seem to have largely dominated latitudes between about 50°-55° and 60°-65°N in the summers and winters alike. This we deduce from the weather maps for individual seasons which we have reconstructed in similar manner to the ones here illustrated in figs. 72a and 72b. It certainly applies to the summers in the decades starting in 1310, 1330, 1340, 1420 and 1430, and to the winters in the 1420s and 1430s. The reconstructions were made possible by the availability in the literature of enough reports from around Europe of those seasons of drought which, enough even to supply some support of each other. The decade maps were produced by averaging the maps of the individual years of the decades referred to. Among the most interesting are the maps for the summers of the decades 1310-1319, when there were famines and economic difficulties, and of the 1340s because of the extraordinary wetness of those summers all over Western and central Europe followed by the heat of 1348 when the plague, the Black Death, arrived. Equally, the winters of the 1430s, which produced a remarkable number of spells of severe weather, produce an interesting decade map.

The climatic effects which marked those decades can nowhere have been stranger to our ideas of normality than in Norfolk – and probably in eastern England generally – where the usually dry climate owes most to the shelter from the prevailing westerly winds and their moisture provided by the hill ridges of southern and western England and the mountains of Wales and
DECLINE IN THE LATE MIDDLE AGES

the Pennines. This shelter was replaced in such times by continual supplies of moisture carried by cold north, northeast and east winds from the North Sea and the Baltic. Norfolk particularly, but also much of East Anglia and northeast England, doubtless became much wetter places than we know today. This seems to be confirmed by the frequency of legal disputes in the local courts in those years in pursuit of people who failed to keep their drains running.

Another part of the map seemed also to be supported by a change of the rainfall experienced. In parts of the Alpine region screened from rainfall from the north by the high mountain ridges, notably in northern Italy (Val d’Aosta) and even in the upper Rhône valley and its tributaries (as in Saas), networks of water channels, essentially narrow wooden aqueducts, were built in this period to bring water from the streams that emerged from the glaciers of the high Alps to irrigate the summer pastures on the valley sides. One of these constructions even brought water from high up in the Val d’Ayas 25 km along the high cliffs of Mount Zerbion and over a pass to deliver it on the south side.

Changes in the geographical distribution of rainfall or snowfall, where mountain shelter is involved, can, as in these cases, provide a sensitive detector of changes of the prevailing winds – a distinctive indicator tool in reconstructing climate patterns. The harshness of the climatic effects of these changes in northern Europe, in Scotland and Scandinavia, in the late Middle Ages, brought about by the apparent frequency of northerly and northeastally winds, is attested by the reports of harvest failures and populations reduced to making bread from the bark of birch trees, and the abandonment of the poorer and more exposed upland farm villages in those countries, and in northern England and Norfolk and the east Midlands besides.

A TIME OF DISEASES

The prevailing wetness during parts of the fourteenth century and, perhaps still more, in the fifteenth century undoubtedly made this an unhealthy time. There were many troubles with the diseases of mankind, animals and crops.

It seems established that in England the average expectation of life decreased by about ten years from the late thirteenth century (when it was apparently about forty-eight) to the period 1376–1400. One of the most horrifying of the diseases of the period – and most clearly associated with the weather – was ergotism, or St Anthony’s fire, produced by the ergot blight (Claviceps purpurea) which blackened the kernels of the rye in damp harvests. Even a minute proportion of the poisoned grains, baked in bread, would cause the disease. The course of the epidemics was such that the whole population of a village would suffer convulsions, hallucinations,
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gangrene rotted the extremities of the body, and death. In the chronic stage of the disease, the extremities developed first an icy feeling, then a burning sensation; the limbs then went dark as if burned, shrivelled, and finally dropped off. Even domestic animals caught it and died. And pregnant women miscarried.

More often mentioned than this disease from the blighted corn in connection with the collapse of confidence and of the economic and cultural structure of Europe's medieval society has been the great bubonic plague, the 'Black Death' which arrived in 1348-50, and its subsequent recurrences. It is estimated that in different districts of Europe from one-eighth to two-thirds of the population died. The consequences in terms of harvests not gathered in, of labour shortage and rising costs, have been much written about. The death rate was heavy in the cities and ports and along much-frequented routes of trade and pilgrimage. Overall probably more than a third of the population of Europe succumbed to the pestilence. Interestingly, the Black Death seems to have originated in China, or in central Asia, in a region where bubonic plague is endemic, during or immediately after exceptional rains and flooding in 1332; this flooding was itself one of the greatest weather disasters ever known, alleged to have taken seven million human lives in the great river valleys of China, and destroying not only the human settlements and their sewage arrangements but also the habitats of wildlife, including of course the rats, over a wide region. Thus, there was a complex of factors in which climate was deeply involved, rather than the Black Death and economic troubles alone or the intellectual questionings of the time, which brought the end of the old medieval era.

DESERPTION OF FARMS AND VILLAGE SETTLEMENTS

The fact that the climatic change played a part, independent of the debilitating effects of disease on the population and on the economy, can be seen in the failures of the northern vineyards in England and on the continent, in the retreat of corn-growing too from its former northern limits and of all cultivation from the heights, and in the depopulation of villages and farms. It is recorded in Nonariam Inquisitiones, a valuation of agricultural production in the year 1341, a few years before the arrival of the Black Death, that there were large numbers of villages with uncultivated land in every part of England, mostly said to be due to shrinkage of population since the famine years earlier in the century but also to soil exhaustion and shortages of seed corn and ploughing teams.

This abandonment of former settlements was going on all over northern and central Europe and on the higher ground even in the south. The sites of many thousands of deserted medieval hamlets and villages have been identified in England the famines of a decade earlier.

Of over eight million deaths, of already reduced population by over 10 per cent, the losses of people who had died in the centre of settlements in the summer and autumn of 1348 and 1349, and of those that had declined in the centre of settlements, can be attributed to a widespread
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identified within the area of pre-war Germany alone. In Germany and
England the phenomenon became prominent in connection with the
famines of the decade about 1315, but had begun even earlier, and was
already reaching its first peak in the twenty years before the Black Death.
Of over eighty deserted village sites for which population figures can be
deduced from tax records in two counties in central England only about
10 per cent were attributable to the Black Death, but all had suffered severe
losses of population in the famine times between 1311 and the 1320s. And
those that did disappear around 1350 were generally the same places that
had declined most (on average by two-thirds) in the years of famine earlier
in the century. The fact that some villages disappeared and others survived
in neighboring positions in various parts of the country has caused many
to doubt the climatic explanation, but it seems that these differences of
fortune can often be explained by differences of soil and exposure. The
coincidence of timing of the waves of desertion over much of Europe points
to a widespread, and presumably external, cause such as the behaviour of
the climate. Moreover, the period when most desertsions took place in England, between about 1430 and 1485, coincides with a fairly well-documented time of frequent cold winters and wretched summers, the latter particularly in the 1450s and later 1460s (fig. 74). But the climatic influence is hinted at most clearly in that it seems to have been Norway that, apart from Iceland and perhaps eastern Europe, was worst hit.

THE SEQUENCE IN THE NORTH OF EUROPE: NORWAY, DENMARK, SCOTLAND

We know a good deal about Norway in the Middle Ages and after, thanks to the wealth of information on taxes, occupations and properties in the 'church books' (kirkebøker) and the pioneer researches by Professor Andreas Holmsen of Oslo. These have borne fruit in numerous indications of the interplay between climatic and environmental history and social history in northern Europe, and inspired the Deseròred Farms Research Project (Odeigardsprosjektet) in which all the northern countries, including Finland and Iceland, have collaborated over many years.

The abandonment of farms began first in north Norway already before 1200, accompanied by an expansion of the areas used by Lapp hunters and a drift of the Norwegian population south and towards the coastal fisheries. At the end of the Viking period there must have been about a thousand farms in Halogaland in north Norway, and they grew barley, oats and rye. By the 1430s, in and near the rich fishery districts in the Lofoten islands up to 95 per cent of the farms had been abandoned, and elsewhere about 60 per cent. At the coast, in fact, the numbers of the population and their economy expanded between 1350 and 1500, and it seems possible that, for so long, the increased cold water outflow from the Arctic near Greenland was compensated by a strengthening of the inflow of the warm Atlantic water with its fish stocks on the Norwegian side. (But later on, in the seventeenth century, the Norwegian fishery too seems to have been affected by the climatic deterioration.)

West Norway was the next to be affected, with some decline of population during the thirteenth century and reduction of the taxes in the 1330s and 1340s on account of lowered farm yields and losses caused by natural disasters such as rock-falls. Owing to the nature of the country there were big variations from district to district and from farm to farm. The decline was on the whole sharpest in the sheltered districts in the inner parts of the fjords and in Trondelag, the district about Trondheim, which had been richest earlier in the Middle Ages. Wheat had been grown there. Particularly interesting is the case of the marginally situated upland farming village of Hovset (fig. 75), 350 m above sea level, east of Trondheim near the Swedish frontier. The place has been the object of interdisciplinary studies by Professors Sandnes and Hafsten and colleagues, notably Dr Helge Salvesen.
DECLINE IN THE LATE MIDDLE AGES

Archaeological work and pollen analysis show that a small area of the forest was cleared for cultivation, including cereals, about the fourth century AD. The farmers may have been attracted by the possibilities of iron production in the neighbourhood. Twice, or perhaps three times, since then the area has been abandoned and reconquered by the forest, each time in periods of colder climate. This is not surprising because in periods of prevailing southwesterly winds Trondelag enjoys the shelter of the great mountains of southern Norway (and some additional warming of the south and southwest winds by an effect like that of the Alpine foehn wind\(^\text{14}\)), but whenever winds from the northwest and north become prominent the district is directly exposed to these winds from the Arctic sea. Høset may have been abandoned first for a time about the sixth to ninth centuries AD. There was, however, a climax of cereal cultivation there in the high Middle Ages, and the two later abandonments were precisely in the periods of sharpest climate stress in 1435 and 1698. Full-scale farming was not resumed there until about 1930.

In the most sheltered part of Norway, the central and southeastern part (Østlandet), the medieval expansion continued right up to the Black Death. It would be correspondingly easy to attribute all that followed to the disaster

![Image of a farm village at latitude 63° 24' N 11° 10' E, east of Trondheim, Norway, 350 m (approximately 1150 ft above sea level). The position is so marginal for agriculture that it was twice abandoned in periods of climatic deterioration in or about 1435 and the 1690s and reconquered by the forest. The first period of cultivation there in earlier times seems also to have gone into decline and possibly been abandoned some time between AD 500 and 900.](image-url)
of the plague. The incidence of the disease itself was very patchy, the death rate amounted to 90 per cent of the population in the great Hallingdal valley, with its through route, and about two-thirds along the pilgrim route to Trondheim through southern Sweden, while blood group research suggests that the more remote parts of Telemark in central south Norway were never touched. But it is noteworthy that there was no real recovery in Norway for about two hundred years. The farms on the higher ground stood empty for that long, partly because any surviving occupants had been able to take up vacant farms on richer land in the valleys. But by 1387 production and tax yields were only from (in some districts) as little as 12 per cent to barely 70 per cent of what they had been around 1300. Even on the bishop’s land near Oslo only oats were grown. And in the 1460s it was becoming recognized that the change seemed permanent. As late as the year 1665 the total Norwegian grain harvest is reported to have been only 67–70 per cent of what it had been about the year 1300, and in west Norway the medieval production was not exceeded until around the middle of the eighteenth century.\footnote{15}

In parts of Denmark, particularly Jutland, near the North Sea, the situation seems to have been not much better, with many farms deserted, corn growing given up and those farmhouses that were still maintained were shared by several families.\footnote{16} English visitors to a Danish royal wedding in 1406 reported seeing much sodden uncultivated ground and that wheat was grown nowhere. There was, in fact, a gradation across the country with much less stress in the more sheltered districts of the islands of Fyn and Sjaelland farther east.\footnote{17}

It is clear that the changes registered in agriculture and husbandry in various parts of Europe in the late Middle Ages were influenced by impact of the climate as well as by the disastrous depopulation brought by the Black Death. The growing season everywhere shortened, perhaps typically by three weeks or more, its accumulated warmth decreased and the frequency of harvest failures increased – the dreaded ‘green years’ when the crops fail to ripen – in the north. Wheat has a rather higher requirement of summer warmth than barley or oats and thrives best in regions where the yearly rainfall is less than 90 cm; but it can be successfully carted wet for drying indoors, whereas the other cereals soon overheat. Rye withstands severe winters better than other cereals and is the most productive grain on poor soils. As the climate deteriorated, barley, oats and rye were therefore to be preferred to wheat except in the warmer parts of Europe. On the other hand, there were many places where cereal growing ceased to be profitable and was given up in favour of sheep rearing to meet the increasing demand for wool.

In the Highlands of Scotland, it seems, the long history of clan warfare and of the Highlanders raiding cattle from the Lowlands, as also in this period the cattle raids from the Southern Uplands across the border into

England, may be the settlements with age of the twelfth-1080s, when King held their court in

Norway, much of northwest and in the benign south connected with the in 1300. The fifteenth north of Scotland in 1411 and faced with such troubles. It ruled the central worsened in the Highlands, as in want of grain. As Scotland was rich in produce. It was Edinburgh Castle in other parts of recorded for the estimated that the in 1315–17.

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England may be explained by the stress of a deteriorating climate upon the settlements which had been established far up the glens in the 'golden age' of the twelfth and thirteenth centuries. As early as the 1070s and 1080s, when King Malcolm III and his queen (who became St Margaret) held their court in Dunfermline, Scotland was a haven for innumerable English exiles from Norman rule. But as in Iceland and in north and west Norway, much of the country is exposed to a drastic change whenever northwest and north winds become more frequent at the expense of the benign southwesterlies. Internal troubles of various kinds, not all connected with the incursions of the English king and his forces, began about 1300. The fifteenth century historian Boece wrote that in 1396 all the north of Scotland was engulfed in clan warfare. There was more of it in 1411 and fairly clearly the fifteenth century was the peak period for such troubles. It was in 1433 that the estate of the Earls of Mar who had ruled the central area of the Highlands collapsed, and poverty rapidly worsened in the region. In that decade of the 1430s in the Scottish Highlands, as in Sweden, bread had to be made from the bark of trees for want of grain. And in the accompanying unrest, in 1436, King James I of Scotland was murdered when hunting on the edge of the Highland region near Perth. It was then that it was decided that at no place north of Edinburgh Castle could the king’s safety be guaranteed, and so Edinburgh became the capital of the country. In the same decade, the severity of which in other parts of Europe we have already noted, death and famine were recorded for the first time in the annals of Dunfermline. And W. G. Hoskins estimates that the famine in England in 1437-918 was second only to that in 1315-17.

The physical background to these developments in the history of Scotland shows itself in the fact that the upper limit of cultivation on the Lammermuir Hills southeast of Edinburgh, which had been as high as 425 m (nearly 1400 ft) above sea level at one point in the mid-thirteenth century, fell in stages until by 1600 it was 200 m lower. Over the period from 1300 to 1500 on the hills of continental Europe, from the Vosges in the west, through middle and southern Germany to Czechoslovakia, the upper tree line fell by 100–200 m. And after 1300–1430 the upper limit of vineyard cultivation in Baden in southwest Germany was brought down by 220 m. These height changes tend to verify the approximate magnitude of the change of summer temperatures as derived in Fig. 30 (p. 84). We also have a register of the climate of this whole period in the yearly growth rings of larches near the upper tree line near Berchtesgaden in the German Alps: between 1330 and 1490 the rings were of unusually variable width, but from 1490 to 1560 there was a period of good growth. Decline followed and from 1590 the growth rings have on the overall average only had half the width of the 1490-1560 period, though 1770-1810 and 1850-1950 appear as relatively good growth periods.
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CENTRAL, SOUTHERN AND EASTERN EUROPE

The changing climate with its enhanced short-term fluctuations, including some runs of three to five years, or even more, of wet, flood-ridden seasons, of droughts and either severe or very mild winters, made itself felt also farther south in Europe after 1300. The wheatlands and the vineyards of northern France shared in the harvest failures and the resulting famine and deaths by the million in the decade beginning in 1310. Ladurie has shown how the dates of the southern French wine harvests beginning in 1349 (but only forming a continuous series from about 1550) can be used as an index of the climate. And K. Müller derived a similar informative index, from the early Middle Ages to our own times, from the percentage of the wine harvests in south Germany which were reported as good in different periods. Although the early records are fragmentary, the German record shows a decline from figures ranging between 30 and 70 per cent before 1300 to figures never above 55 per cent and at times under 20 per cent between 1400 and 1700.

In the widespread famines of the 1420s and 1430s there were reports of cannibalism in eastern Europe, as there had been also in the west in the 1310s. The repeated famines gave rise to an emigration from Russia westwards into Germany. (It would be useful to have an estimate of the size of this population movement.) And in the severe winters in the 1430s the wolves were active in many parts of Europe, from Smolensk in the east to England in the west. (In England, but not in Scotland or Ireland, this may have been the last time that wolves were reported.)

It was not only in the Highlands of Scotland that there was turmoil in the fifteenth century period of climatic stress. In Denmark and in what is now the southern province of Sweden (Skåne) the deepening crisis in agriculture led to a drift to the towns and by the end of the century apparently to a more general emigration affecting the towns as well. In Bohemia the 1420s and 1430s saw the Hussite risings; and, although these were basically concerned with religious and political ideas of democracy and independence, we may suppose that the times of bad weather and harvest failures made many people rootless and more readily persuaded to join the conflict. Something of the same influences may have applied in England, where the Wars of the Roses dragged on from 1455 to 1485: Trevelyen mentions that, although the common people were probably little concerned about the dynastic causes of these campaigns, the effect of starvation and the run-down state of the country on soldiers returned from France and the Hundred Years War probably encouraged them to enlist. In many, perhaps most, parts of Europe — in England, Sweden and south Germany, for example — it was in the fifteenth century that the main abandonment of the small, unsuccessful settlements occurred. In England John Rous of Warwick, writing in 1485, listed fifty-eight sites, mostly in that one county,
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which had become depopulated in his lifetime. There was much agitation about the conversion of previously tilled land to other use, usually sheep rearing (with the shepherds using any abandoned houses, which had not fallen or been pulled down, for shelter). And the landlords who organized the conversion and enclosed the land became a focus of hostility. In Germany the rising civic pride and splendour in the merchant cities in the fifteenth century seems to have been linked to some extent with the drift to the towns and the protection which they offered against the lawless state of the countryside, in which peasant revolts grew worse until the general rebellion in 1525.

In European Russia a greater proportion of the apparently increasing climatic troubles after 1300 seem to have been due to summer droughts than further west. This trend seems to be confirmed by the general decline of ring widths shown by the timbers used in the successive surfacings of the streets of medieval Novgorod. There seems also to have been an increasing incidence of severe winters. And the impression given by the chronicles of the monasteries is that the results were of a severity in terms of famine and loss of life, and indeed of the frequency of such events, unmatched in western Europe except in a few decades such as the 1310s, 1430s and 1690s.

In southern Europe, although we have so far disappointingly little direct evidence of the climate in the fifteenth century, grain prices and vintage dates alike suggest that there were no severe effects in the 1430s nor from other parts of the period between about 1420 and 1480 which produced so many harsh seasons farther north. (Fig. 33a, p. 88, suggests that the southwest peninsula of England escaped similarly.) Preliminary meteorological analysis of the 1430s indicates an extraordinary predominance of blocking anticyclones over northern Europe. The southerly winds at the western limit of the anticyclones could well explain the impression that this period was one of some recovery in Iceland. If this analysis is right, the fifteenth century probably saw an abnormal amount of cyclonic activity in parts of the Mediterranean, giving more rainfall than is now normal there but few extremes of temperature. It is greatly to be hoped that the documentary archives of the Spanish and Italian cathedrals will some day be systematically studied for what they may contain in the way of direct information on the climatic history of the Mediterranean region.

DEVELOPMENTS IN AFRICA AND INDIA

Farther south again, in the desert regions of north Africa the writings of the great Arab geographers indicate that there was more moisture than now all through the high Middle Ages and after, from the eleventh to the fourteenth centuries. This probably applied to Arabia too. There are descriptions of journeys across the Saharan region from the north African fringe.
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to Ghana and Mali and to the Kufra oasis (24-25°N 22°E), in the eastern desert. The desert did not extend north of latitude 27°N. Crossing of the uninhabited region took two months, but even there, on a journey in 1352, it was reported that a large number of wild cattle often approached the caravan. By that date it seems, however, that a drying tendency had set in, since it was also remarked that the rearing of beef cattle had been given up in the Kufra region. Formerly, great herds had found pasture there in regions which had become desert. From the thirteenth century until the fifteenth there was a Mali empire, which at its height between 1307 and 1332 is said to have covered most of west Africa. In 1325 the Mali sultan built a royal palace in Timbuktu and a tower for the mosque. After the temporary loss of Timbuktu, Mali power was restored there in 1353 and continued until it was abandoned to the Tuareg nomads in 1453. Although it can never be safe to deduce climatic changes from human political history, in this extreme region the events described most probably confirm that drying out of the desert region was proceeding and causing increasing difficulty. In the meantime, we do know from the pollen analysis researches of J. Maley of the Université des Sciences et Techniques du Languedoc at Montpellier in France that in the Lake Chad Basin there was a maximum occurrence of the pollen of the plants of the Sudan-Guinean monsoon zone flora between about AD 700 and 1200 and that these and other water-demanding plants declined rapidly over the period 1300-1500. A curious feature of the period between the moisture optimum around AD 700-1200 and the greater difficulties experienced in this area in the Little Ice Age is that there were successive waves of human migration southwards at two-hundred year intervals, in the thirteenth, fifteenth and seventeenth centuries. In these regions we may hope for further and more direct information from the Arab libraries, which are reported to contain records of at least the more important years of drought, and from the continuing studies and dating of the former levels of Lake Chad and other African lakes.

The position is rather similar regarding the climatic sequence in the Indian subcontinent. K. S. Lal has described the sources of information on famines and population in India during the Middle Ages and after. Although the data on famines and behaviour of the monsoon in this early period have not been analysed yet, the population estimates are interesting, since they once again produce a sequence which (apart from the underlying long-term increase) roughly parallels our estimates of the temperature trend in higher latitudes. According to Lal, the best estimates of the total population of the subcontinent rise to a maximum, around 200 to 300 millions, about AD 1000, already fall slightly to 190 to 200 millions about AD 1200 and to 170 millions in 1388, followed by a sharper fall to a minimum, around 120 millions, between about 1525 and 1550. Around 1600 a population of about 130 to 140 millions is suggested. When all

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allowance is made for the effects of wars and massacres, it seems likely that famines and disease must be the main explanation for the fall of population on such a scale as is indicated in the late Middle Ages.

THE SEQUENCE IN NORTH AMERICA: HOW THE PRE-EUROPEAN CULTURES WERE AFFECTED

When we turn our attention to North America, the researches carried out by the Institute for Environmental Studies in the University of Wisconsin at Madison under Professor R. A. Bryson indicate drastic population shifts, the timing and the nature of which point strongly to a meteorological explanation. About AD 1000 the Amero-Indian people had been growing corn all across the high plains from the base of the Rockies, through eastern Colorado and western Nebraska; and farther east there were substantial settlements in the river valleys, where oaks and cottonwoods grew. One of these places, now known as Cahokia, in southern Illinois, just east of St Louis, is estimated to have had a population of 40,000 people. From pollen analysis studies, and from counting the bones of different animals found in the refuse dumps (or kitchen middens) of these farming and hunting communities, Bryson and Baerreis have found that the scene underwent a rapid change after AD 1200. There was less change in the valleys close to the watercourses, but the oaks disappeared in most of the places where they had grown, and the overall numbers of trees declined in favour of the plants of the prairie. And among these the shorter grasses gained at the expense of the bigger, more moisture-demanding types. At one site investigated in northwestern Iowa the increase of grass pollen from a negligible proportion to about 70 per cent of the non-tree pollens took only forty-five years or less. Correspondingly, the forest animals, the deer, gave way to bison in the people's diet. These are signs of a significant decrease of rainfall. Moreover, this suggestion accords with the idea of increased dominance of the west winds, generated by the increased north to south gradient of temperature at a time of cooling of the Arctic. This would extend the rain-shadow effect of the Rocky Mountains farther east than before and intensify the dryness within it. The picture is completed by wholesale abandonment of the settlements after about AD 1200. At first, it seems the smaller villages in the driest areas were deserted and people tended to congregate in the bigger places in the river valleys. But ultimately even the biggest of them, Cahokia, was abandoned, seemingly about 1300; and when the first European (French) traders arrived in the area in the eighteenth century they found only scattered, small Indian settlements. As Bryson and his collaborators have demonstrated, the rainfall pattern over the United States in one of those summer months in modern times that have more than usual development of the westerly winds typically produces a long eastward-pointing 'finger' of severe rainfall deficiency.

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exceeding 50 per cent, an extension of the rain-shadow of the Rocky Mountains. And this feature is so placed that the main concentration of the village sites of the Mill Creek culture in the northern Middle West and Cahokia itself lay close to its axis. In the always drier parts of the plains nearer the Rockies the change in the thirteenth century was plainly catastrophic. all the small village sites there were soon abandoned.

Bryson estimates that the period of extreme dryness lasted two hundred years and coincided with the strong development of the circumpolar vortex which carried the westerlies mostly far to the north in the European sector, accounting for the warm periods of the thirteenth and fourteenth centuries there but also for the vigorous development of the cyclonic rains in Europe around 1315 when the westerlies came farther south. Much farther south, over the southern plains in northwestern Texas and adjacent parts of Oklahoma, the same investigation indicates that there would be an increase of rainfall - as appears to have occurred in the Mediterranean in the high Middle Ages - and it may have been substantial. It is presumed that it was towards these regions that the former population of the northern plains went. Certainly, archaeology indicates that the numbers inhabiting the so-called Panhandle region of Texas rapidly increased around AD 1200.

Karlstrom and his associates in the US Geological Survey and in the University of Northern Arizona at Flagstaff have found that the Indian populations on the Colorado plateaux and neighbouring parts of northern Arizona and New Mexico experienced changes corresponding to those over the northern plains.\textsuperscript{30} The economy was based on maize, squashes (i.e., plants of the pumpkin family) and beans, and some wild plants, supplemented by hunted game. The population had been increasing and spreading over the area from AD 550 or thereabouts, until between 800 and 1150 almost every habitable part of the plateaux was occupied. It was these people who created the great cliff dwellings of the Mesa Verde and built the many-storied stone villages and towns of Pueblo Bonito and the Chaco Canyon in the tenth to thirteenth centuries. They also built water control channels, roads and signalling stations. But after 1150 many areas, especially in the higher parts, were deserted in favour of positions along the bigger stream courses and more control channels for water for irrigation and domestic use were provided. After 1300 the former homelands were almost entirely deserted and the population had moved south and southwest, along the Rio Grande and to the Hopi Mesas area in central Arizona. The associated environmental changes, particularly in terms of moisture availability and water table, were demonstrated by pollen studies and tree ring work, which was also used for the dating.

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THE LITTLE ICE AGE

Background to the history of the sixteenth and seventeenth centuries

THE SIXTEENTH CENTURY

During the sixteenth century we reach the period from which a great many more documentary reports of the weather survive. This is particularly true for Europe, where the reports are increasingly specific, verifiable and often precisely dated. But also around this time documentary reports begin to be available for other parts of the world. And the middle and later seventeenth century provides the earliest instrument observation records. These, like the evidence of the glaciers in many parts of the world and of the Arctic sea ice, introduce us to a colder climate than that of the twentieth century. In England the late seventeenth-century thermometer record indicates annual mean temperatures about 0.9 °C (1.6 °F) lower than in the period 1920–60. Over the years 1690–9 the deficit was 1.5 °C (2.7 °F).

The temperatures which we derive from the sixteenth-century material available for England (fig. 30, p. 84) and other parts of Europe, like the indications of tree ring width in California (fig. 52, p. 141) and the palaeotemperatures indicated by isotopic studies of the calcite in a cave in New Zealand, point to generally rather warmer conditions between about 1500 and 1550 than in the previous century. We cannot yet say whether this was (in terms of the wind circulation patterns) any sort of counterpart to the temporary recovery in part of the fifteenth century registered by isotope measurements on the north Greenland ice (fig. 36, p. 93) and which seems to have affected Iceland too. The warmth of the early sixteenth century in Europe was probably produced by rather frequent anticyclones affecting the zone near latitudes 45–50 °N and westerly winds over northern Europe, whereas the previous century—like the period from 1550 to after 1700—was characterized by a remarkable frequency of anticyclones north of 60 °N and winds from between northeast and southeast over Europe south of that latitude.

Despite the mostly genial character of the period 1500–50, there were at least three winters in England with enough severe weather to freeze over the Thames in London—it froze more easily in the days before the tributary
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streams were put into pipes and the new bridges allowed the tides to reach so far up the river — and the summers of the 1530s on the continent alternated in quality so strongly that graphs of the tree ring record from the oaks in Germany and the vintage dates recorded in France and Switzerland produce a regular saw-tooth zig-zag appearance.\(^3\) (This Sägesignatur is a prime example of the more or less biennial, or alternate years, cycle which is present and at times prominent in many series of climatic data.) These observations suggest that the warmth of the 1500–50 period in Europe did not quite match that of 1900 to the 1950s, though the difference was probably not great. From examination of weather diaries covering the years 1508–31 from two places in Bavaria (Eichstätt and Ingolstadt) Professor Flohn found no significant difference of the winter temperatures from the level of 1880–1930, but the summers were on average slightly (7–8 per cent) wetter and by implication less warm.

In the middle of the sixteenth century a remarkably sharp change occurred. And over the next hundred and fifty years or more the evidence points to the coldest regime — though accompanied by notably great variations from year to year and from one group of a few years to the next — at any time since the last major ice age ended ten thousand years or so ago. It is the only time for which evidence from all parts of the world indicates a colder regime than now. This may reasonably be regarded as the broad climax of the Little Ice Age, though we can distinguish some severer years and decades within it and others that were less so. From another point of view it would be reasonable to regard the whole period between about 1420, or even 1190, up to 1850 or 1900 as belonging to the Little Ice Age development.

THE CHANGES IN CENTRAL EUROPE:
1500s TO 1800s

In a weather diary kept at Zurich from 1546 to 1576 the relative frequency of snow among the snowy and rainy days of winter was 44 per cent up to 1563 and 63 per cent from 1564 onwards. From this and similar statistical studies of other data Flohn has concluded that the mean winter temperature from 1560 to 1599 in central Europe was about 1.3 °C lower than in 1880–1930 or the first half of the sixteenth century, while Tycho Brahe's observations in Denmark from 1582 to 1597 seem to imply winter temperatures 1.5 °C lower there than in about the same modern period used for comparison. We also know from the Danish observations, as well as from a survey of ships' experience on the seas between the Netherlands and southern Europe, that easterly winds became prominent. In Tycho Brahe's observation series in Denmark the southeast was the commonest single direction over the year as a whole, and northwest winds were as common as southwest. No equally reliable assessment of the summer temperatures,
Europe.

The relative frequency of wet and sunny weather in Europe has been increasing since the end of the Little Ice Age (ca. 1850-1900), leading to a marked change in the climate of western Europe. This is reflected in various proxy records, such as tree rings, pollen analysis, and historical documents. The 19th century was a period of relatively warmer and drier conditions compared to the previous centuries.

In the Netherlands, for example, the summer temperatures in 1830 were as warm as any summer on record from the 18th century. Similarly, the summer temperatures in England were also unusually warm, with some summers reaching temperatures similar to those of the 19th century. This period of warmth is often referred to as the 'Climate Optimum' and is thought to have been due to a combination of natural and human-induced factors.

The increase in summer temperatures during the 19th century has had significant impacts on the local environment and ecosystems. For example, the expansion of forested areas and the increase in the number of species that thrive in warmer climates is evident in many parts of Europe. The rise in temperature has also led to changes in the agricultural landscape, with crops and crops adapted to warmer climates becoming more common.

However, the warming trend was not uniform across the continent. Eastern Europe experienced colder temperatures during the same period, which may have had different implications for the local environment and human activities. The study of climate change in the 19th century continues to be an active area of research, with scientists working to better understand the causes and effects of these changes.

The Little Ice Age (ca. 1450-1850) was a period of cooler temperatures, with widespread glacier formation and reduced agricultural productivity. The end of the Little Ice Age was marked by a significant increase in temperatures, leading to the 'Climate Optimum' of the 19th century. The transition from one period to the other was gradual, and the effects of these changes were felt across the entire continent. The study of climate change in the 19th century continues to be an active area of research, with scientists working to better understand the causes and effects of these changes.
as far forward as it was around 1900, reaching the broad valley bottom at the foot of the steep ascent to the Furka pass, though by no means reaching the size it had in the eighteenth century.) Pfister has examined the later eighteenth century recurrences of cold wet years in more detail, using the instrument readings of the climatic observation network set up in 1759 by the Economic Society of Bern. There were strong short-term fluctuations: the years 1759-63 and 1778-84 had a warm tendency; but the period
The broad valley bottom at the end of the period was still more than 20 km wide, though by no means reaching the dimensions of the modern Rhône valley. The glaciers have advanced and retreated many times, but the period of greatest regression was in the 18th century.

Fig. 77 The Rhône glacier viewed from the same viewpoint:
(a) (top) in 1750; (b) in 1930.
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1764–77 was notably cold, the summers being rainy on the Swiss lowlands and snowy in the Alps, the winters long and snowy, especially around 1770. The summers were too short to melt the snows on the alpine pastures, and the glaciers advanced strongly; and in 1769–71 the dearth of wheat, potatoes and milk produced famine. There was a brief repetition of conditions similar to these in 1812–17, with famine in 1816 and 1817.

Pfister has also been able to study weather diaries from the areas around Bern and Zurich from the year 1683 onwards and finds that the average number of days a year with snow covering the ground was about 70 in the first twenty years, 75 in the 1690s, though in the ten years 1705–14 it was as low (42 days) as in the decade (the 1920s) of mildest winters in the present century. More remarkably, the winters of 1684–5, 1730–1, 1769–70 and 1788–9 produced totals of about 110–112 days around Zurich and in 1784–5 over 150 days in Bern. It is thought that 1613–14 also had about 150 days. These figures are to be compared with the total of 86 days recorded in 1662–3, the longest winter in Switzerland of the last hundred years. By statistical methods Pfister has been able to derive temperatures from the weather observations in these diaries and finds that the mean winter temperatures in Zurich in 1683–1700 were 1.5 °C below the 1900–60 average (which agrees well with the departure derived for central England, from the data used in fig. 30, p. 84). The greatest deviation from modern times was, however, in the months of March, which averaged 2.2–2.7 °C (4.9 °F) colder than in the present century. March was a full winter month and in all the extreme winters mentioned in this paragraph had a complete snow cover throughout. In 1687 at Einsiedeln (882 m above sea level) this applied to April also, and in the three years 1699–1701 the snow cover lasted until 15 May, implying mean temperatures 4–5 °C below the modern average. The effects of these years on the Swiss farms were drastic. It seems that the grain crops suffered from attacks of a parasite, *Fusarium nivale*, which is active under snow cover in spring in Scandinavia and northern Germany but is not known in Switzerland today. And the stocks of hay for the animals ran out when the snow still lay in March and April, so that the cattle had to be fed on straw and pine branches and many cows were slaughtered.

Having gauged the situation in Europe where we have these details, let us now survey the situation around the world as we have done for earlier periods in the preceding chapters.

ICELAND AND THE ARCTIC FRINGE

Greenland, as we have reported (see also fig. 29, p. 60), was already cut off by the spreading of the Arctic sea ice. And by the 1580s the broad Denmark Strait between Iceland and Greenland was in several summers found entirely blocked by the pack-ice. In Iceland the effects were most severely

As we have seen in 1848 there was a separation of the air masses that became more intense

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severely felt in all the northern districts and in the east and southeast of the island. Later, around the end of the seventeenth century, there are documentary records of the advancing glaciers and cut downs. And from about 1480 onwards there had been disasters, entailing losses of farmland, through glacier bursts connected with volcanic activity under the ice and consequent river floods bringing torrents of sand and gravel with them. These jökulhlaupar characteristically lasted about one week, and are estimated to have brought a maximum river flow a thousand times that of the Thames. During these times, therefore, there was a general drift from the farms towards the coast, and an increasing activity in the fishing, in the more sheltered southwest of the country. The overall decline of the population, which we have noted in the last chapter, suggests that there may also have been at least some emigration out of the country altogether. The sea ice was rendering (albeit with many shorter-term fluctuations) to increase further and in the worst year, 1695, surrounded the country entirely so that no ships could come in for many months. We have referred in chapter 4 to the still greater spread of the Arctic cold water. In these circumstances the cod fishery, which had been the island’s relief, ultimately also failed, even in the southwest of the country, for twenty years, from 1685 to 1704. The primitive equipment used by the Icelanders for their fishery in those times played a part in the failure, for foreign vessels operating 20 km off the south coast were able to obtain cod. At the Faeroe Islands the fishery failed for thirty years, and it seems that the cold water was extensive in that direction. As late as 1756 the Arctic sea ice was again at the coasts of Iceland for thirty weeks.

During the period of these manifestations of strong cooling of the Arctic, and its spread to middle latitudes, there were two sectors of the far north, in Alaska and Lapland (northernmost Finland), where the tree ring records show that a more genial climate allowing good growth continued until 1580 or somewhat after. This can reasonably be attributed meteorologically to frequent anticyclones, with sunshine and some southerly winds, in those sectors (which are still particularly prone to blocking anticyclones today). These were doubtless the same anticyclones that were responsible for the frequent northerly and easterly winds over much of Europe and North America at that time.

GREAT STORMS AND COASTAL FLOODS
IN EUROPE

As we have remarked in connection with fig. 23, the spread of the Arctic ice to Iceland and of the polar water to the region of the Faeroes meant that the surface of the North Atlantic between these and southeast Iceland became 5°C colder than is usual today. Consequently, there was a greatly strengthened thermal gradient between latitudes 50 and 61 to 65°N. This
seems to have been the basis for the development of occasional cyclonic wind storms over this part of the North Atlantic exceeding the severity of most of the worst storms of modern times. This is suggested by the many coastal disasters from sea floods - even at a time of slightly lowered sea level (as indicated by the first tide gauge, installed at Amsterdam in 1682) - and erosion and blowing sand. It is most clearly indicated by meteorological analysis of the weather reports available from the Spanish Armada in 1588 (fig. 78). The analysis of the weather situations on sixty days during the Armada's expedition fixes the positions of the depression centres with sufficient accuracy to indicate that their rates of travel on at least six occasions during that one summer corresponded to jet stream winds at the limit of, or beyond, the maximum speeds expected from modern experience.

The development of great storms in this zone continued: from the vast North Sea floods and loss of life on the continental coasts in 1570, mentioned in the last chapter, to the permanent losses of land from the Danish, Gert Nørstrøm) Culbin Sands four-thousand to the great storm (New Style ed. The Eddystone in towns and in London all were blown off the usual recent are said to haveLoaded by the wind in each of wind on many apparently more of growth - Middle Ages difference make such floods by storminess.

A bizarre occurrence resulting from the arrival about 1690 and 17. in his kayak. iton-based cod fishery, it - only a few 5°C colder today - reports by lea the Cairngorms thrives best mable indicator below 2°C at the Faeroe until, as we see between 167° the ice surround disappeared in the early 19th century.
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Danish, German and Dutch coasts (and demolishing of the island of Nordstrand) in the storm of 21 October 1634; to the formation of the Culbin Sands in northeast Scotland in 1694, and the overwhelming of a four-thousand-year-old settlement site in the Hebrides with sand in 1697; to the great storm which passed across southern England on 7-8 December (New Style calendar) 1703 and was described in careful detail by Defoe. The Eddystone lighthouse near Plymouth was blown down, as were houses in towns and countryside all across England to the east coast; the damage in London alone was estimated at £2 million; enormous numbers of trees were blown down; and many ships were blown up-river, or lifted beyond the usual reach of the tides, or wrecked on the coast and at sea; 8000 lives are said to have been lost. Despite the severity of these floods on the continental side in 1634, 1671, 1682 and 1686 and again at Christmas 1717, in each of which some thousands of people were drowned, and losses of land on many other occasions besides, it is unlikely - in a cold epoch of apparently more or less world-wide extent with glaciers generally in a state of growth - that the general sea level was as high as it had been in the Middle Ages around AD 1000 and between 1200 and 1400, though the difference may have been only of the order of 50 cm. The frequency of such floods between 1570 and about 1720 must be attributed to greater storminess.

EFFECTS IN SCOTLAND

A bizarre occurrence - serious for the individuals concerned - presumably resulting from the great southward spread of the polar water and ice was the arrival about the Orkney Islands a number of times between about 1690 and 1728, and once in the river Don near Aberdeen, of an Eskimo in his kayak. The situation in Scotland itself became serious. The recognition, based on the reports of sea ice and the fisheries, particularly the cod fishery, that the ocean surface between Iceland and the Faeroe Islands - only a few hundred kilometres to the north of Scotland - was probably 5°C colder than it usually is today at last makes sense of the numerous reports by learned travellers of the time of permanent snow on the tops of the Cairngorms and elsewhere on the Scottish mountains. The cod, which thrives best in rather cold waters at between 4 and 7°C, serves as a valuable indicator in this connection, because its kidneys fail at temperatures below 2°C and it therefore cannot venture into colder seas. The cod fishery at the Faeroe Islands began to fail about 1615, and did so increasingly until, as we have noticed, there were no cod thereabouts for thirty years between 1675 and 1704. In the worst year, the same year 1695 in which the ice surrounded Iceland, cod became scarce also in Shetland waters and disappeared from the entire coast of Norway (except for a colony apparently surviving in the inner part of Trondheim fjord). It seems safe to infer
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that the Arctic cold wave had spread across the surface of the whole Norwegian Sea. And although there was some immediate improvement the
next year, the sea conditions seem to have been significantly colder than
today until well after 1800.

The course of the development in Scotland and the periods of most
severe climatic stress can be identified in the records of famines brought
together in fig. 79. The information used in this diagram was mainly
compiled from the economic records, annals, and chronicles surveyed by
Lynne and Smout. Although most of the data relate to eastern Scotland,
there are indications that the situation was worse in the north and in the
poorer Highland districts in the west. The experience of recurrent famines
in the later decades of the sixteenth century was at work in the movement
of emigration from Scotland, then beginning, which was destined to become
a well-known theme in the following centuries. Smout writes that 'the
stimulus to leave Scotland was compounded of many factors, of which the
general poverty and discomfort of the native land was the most obvious
... Ulster and (later) America offered empty territory; Holland and England
offered mercantile ships and Russia, Sweden, Denmark, France and all the
petty principoms of Germany offered military opportunity' (p. 90). The
Scottish mercenary soldier who figures in the writings of Sir Walter Scott
was a familiar figure in the wars which troubled Europe in the seventeenth
century, particularly in the service of the Swedish king in central Europe
in the Thirty Years War: 'by 1660 the stream of military migration had
fallen off ... Nevertheless even in 1700 there was hardly an army north
of the Mediterranean without Scottish officers of some sort' (Smout,
p. 92). But the most serious legacy of this time survives to our own day
in the 'plantation' in 1612 of Scots farmers in the richer lands and more
sheltered climate of Ulster in northeast Ireland after first evicting the native
Irish. This seems to have been a device of King James VI at one stroke to
stabilize the Irish political and religious situation in his favour and to relieve
the impact of harvest failures in Scotland, by taking advantage of the power
over Ireland that fell to him on his accession to the throne of England. In
modern terms, it would surely be regarded as a model of how not to
direct international relations and a characteristic abuse of (near-)absolute
power. It is estimated that by 1691 there were 100,000 Scots in Ulster,
already about a tenth of the population of Scotland, and their numbers
were soon to be swollen again by emigrants abandoning their Scottish
homes in the disasters of the 1690s. Unlike the protégés from elsewhere
who were introduced into Ireland in the seventeenth century, these were
mostly humble folk who tilled the soil themselves.

If the Ulster plantation of 1612 was related in any way to the dearth
in Scotland in that year, which doubtless awakened unhappy memories of
the 1590s, it seems to have been an over-reaction. For more than sixty
dearths and famines were less frequent in Scotland than they had
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Fig. 79 Years of reported dearth (broken lines) and famine (full lines) in Scotland between 1550 and 1700. The information is mainly from eastern Scotland. Years with severe losses of stock (sheep and cattle), usually because of snow, are marked by dots.

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been in the last forty years of the previous century, but from about 1670 the situation deteriorated again, with tremendous snows and frosts in that year and huge losses of sheep in the thirteen days of continuously drifting snow in early March (by the modern calendar 1674). Worse was to come in the last years of the century, when between 1695 and 1700 the harvests (largely oats) failed in seven years out of eight in all the upland parishes of Scotland. There are many accounts of those years parish by parish in the volumes of the *Statistical Account of Scotland* compiled by Sir John Sinclair a hundred years later. The poorer sort of people frequented the churchyard to pull a mass of nettles, and frequently fought over it... which they greedily fed upon...” (parish record of Duthil and Raithiemurchus in north central Scotland). Some were reported to have sold their children into slavery. In parishes all over the country from one-third to two-thirds of the population died — a greater disaster in many places than the Black Death — and great was the fear of being buried in a mass grave. Some whole villages and wide tracts of the countryside were depopulated at this time (fig. 80). And Andrew Fletcher of Saltoun in Midlothian appealed in the Scots parliament in Edinburgh in 1698 that the well-to-do should ‘grudge themselves their luxuries’ and recognize the nation’s need, mentioning that ‘from unwholesome food diseases are multiplied among the poor people’ and that perhaps 20 per cent of the population of the country were reduced to begging from door to door. To the Jacobites these were the ‘ill years of King William’s reign’, but to the rest of the population they probably made the union with England in 1707 seem inevitable.

A measure of the lowering of the general level of the temperatures prevailing in the northern and eastern Highlands of Scotland in those times is indicated by one or two reports of high-level tarns, or lochans, which had ice on them all the year round. Thus, there is a report in the Philosophical Transactions of the Royal Society dated 1675 of a little lake in Straglach [Strathglass] at Glencairnich on land belonging to one Chisholm... in a bottom between the tops of a very high hill... This lake never wants [lacks] ice on it in the middle, even in the hottest summer. We also have the travellers’ reports of permanent snow on the tops of the Cairngorms. These observations seem to require temperatures 1.5-2.0 °C below twentieth century values averaged over the year, a lowering twice to three times as great as that which has been substantiated in central England from actual thermometer readings, though not unreasonable in view of the apparent advance of the polar ocean water southeast of Iceland (see ch. 4, pp. 61, 205, and fig. 23).
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Fig. 80 The site of a village, Daintoun or Upper Davidstown, in the southern uplands of Scotland, which was abandoned in the 1690s. The slope faces north and is 275 m (900 ft) above sea level. (a) (top) General view from the north, (b) at the site, looking northeast. The rectangular shapes of the footings of house-walls can be seen in the pictures. (Photographs kindly supplied by I. J. W. Poatey.)

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SCANDINAVIA AND FINLAND

As might be expected, the situation in Scotland was largely paralleled in Norway. In spite of the degree of recovery in the country in parts of the sixteenth and early seventeenth century, the total number of farms in 1665 was less than it had been around 1300, and there were more desertions later in the seventeenth century, among them the whole village at Hoset (as noticed in the last chapter). Over the next hundred years farms were in some cases overrun by the advancing glaciers and their land partly destroyed by avalanches, floods, rock-falls and landslides. On the Hardanger Vidda plateau small new glaciers were formed, one or two of which survive as dead ice today. Between 1936 and 1951 two sections of a rope fence, which had been erected on a mountainside near Olden in Nordfjord in west Norway by the farmer who owned the land from 1602 to 1624 to protect his sheep from wolves, were found to have been released from the snow and ice which had covered it in the intervening time. It seems that the climatic deterioration did not strike Norway as soon as Scotland and Iceland, although there were some harvest failures at the end of the sixteenth century. The country probably benefited from the influence of the

Fig. 81. Three nineteenth-century pictures showing the types of boat and the methods of drying cod used in the Norwegian coast fisheries over some hundreds of years: (a) A vessel with cargo in rough water on the west coast making for Bergen (picture published in Norsk Penning Magasin in 1836, but which apart from the flag could be in the sixteenth century).
was largely paralleled in country in parts of the number of farms in 1665 or were more desertions whole village at Hoset andred years farms were and their land partly slides. On the Hardanger or two of which survive sections of a rope fence, Olden in Nordfjord in from 1602 to 1624 to been released from the ring time. It seems that as soon as Scotland and at the end of the six the influence of the

The types of boat and the series over some hundreds the west coast making for in 1836, but which apart century).

Fig. 81 — continued (b) A rowing boat and fishing station with cod hanging up to dry (from Norsk Skilling Magasin 1868). (c) Split cod drying on the rocks near Kristiansund. (Photograph 1935 by Wilse, in Norsk Folkemuseum.) (The pictures at (a) and (b) were republished in Kari Lindbekk, Lofoten og Vesterålen Historie 1500–1700, Kommunene i Lofoten og Vesterålen 1978; copies of the pictures were kindly obtained and supplied for this book by Ivar Toft and Øystein Bottolfson of Stokmarknes in Vesterålen. The picture at (c) was similarly obtained and supplied by Professor Trygve Solhaug of Bergen.)
anticyclones and southerly winds of which we have noticed evidence in the
tree rings in Lapland. The taking up again of long-abandoned farms on
the higher ground in south Norway continued until about 1640. A
reassessment of farm and land values carried out with great care in 1667
put up the taxes and land-rents, which were paid in kind, above what they
had been in the previous century. But troubles and difficulties imposed by
nature began soon after that. Reports of rock-falls, avalanches, landslides
and flood damage led to pleas for reduction of taxes which were meticu-
lously investigated and generally granted. By the late 1680s and 1690s these
incidents had multiplied manifold, and the glaciers themselves were over-
running farmland. There was a great frequency of disasters in these
categories in Norway between about 1690 and 1710, which continued
with little abatement until the middle of the eighteenth century and then
tailed off to reach a negligible level in the middle decades of the present
century.

The worst years for the harvest in the Trondheims district of Norway
often came three in a row, according to an eighteenth-century Norwegian
historian, G. Schønning, writing in the first volume of the Trondheims
Society's Skrifter (1761). He lists 1600–2, 1632–4, 1685–7, 1695–7 and
1740–2 as examples. In many of those years, however, the herring fishery
was better than usual. Schønning wrote: 'the natural cause of this is without
doubt that the self-same conditions which produce harvest failures with us,
namely long-lasting harsh and stormy westerly and northerly winds . . .
drive the great fish stocks of the Arctic Ocean [Barents Sea] in greater than
usual numbers to our coasts'. This explanation was no doubt broadly right
except in relation to the extreme situation in the 1690s when the fish seem
to have been driven altogether farther south.

In north Norway the population fluctuated remarkably during the
sixteenth and seventeenth centuries with the variations of the fisheries, as
can be established from the taxation documents. In Lofoten and Vesteralen
there was a maximum of population about 1618, followed by a 20–30 per
cent fall over the next thirty years, then an even greater maximum in the
1650s followed again by a nearly 30 per cent fall to the end of the century.
It seems that these changes must have involved migration of fisherfolk in
and out of the region from the south. The climate connection is partly
obscured here by the effect of changes, controlled by war and peace in
central Europe, in the amount of trading of fish – notably dried cod – for
corn from the eastern Baltic lands (fig. 81). But it is clear that the fisheries
were in poor shape in the latter part of the seventeenth century and that
farms were once again being abandoned on a considerable scale in north
Norway especially in the later decades of the seventeenth century.

In Sweden most of the same pressures are registered elsewhere in
northern Europe, though less severely than in Norway or Russia. (There
seems no mistaking that northerly storms in the Norwegian Sea and the

FISHER

The Baltic and Adriatic littoral has always been characterised by its
culture and by its trade. The forgotten fact, however, is that the
Baltic was, in the Middle Ages, a war area. The Baltic countries
were a vast domain of the Teutonic Order, but the Baltic
nations were never able to make the Baltic a great
littoral. The Baltic littoral was always subject to
Russian domination. The Baltic littoral was always
subject to the power of the Teutonic Order. The
Baltic littoral was always subject to the power of the
Teutonic Order.
noted evidence in the Sogilab abandoned farms on the land, above what they called the difficulties imposed by floods, avalanches, landslides and fires which were catastrophic in the 1680s and 1690s. These fires themselves were overtaken by a series of disasters in the 1710s, which continued into the eighteenth century and then only for decades of the present.

In the Trondelag district of Norway, the seventeenth-century Norwegian volume of the Torondel study, 1685–7, 1695–7 and 1699–1600, followed by a list of districts in other parts of the country, shows the effect of the severe winters in Russia, the prime aspect of the climatic deterioration. In north Sweden there is little sign of the retreat of settlement and agriculture that was so widespread in other parts of Europe, probably because the country was best suited for habitation and had been occupied. And in Finland deserts had hardly begun to form until after the seventeenth century, although there was some migration of Finns to settle farther south in Sweden and Norway already in the sixteenth century.

FISHERIES AND THE SEAFARING NATIONS OF NORTHERN EUROPE

The Baltic and North Sea—Norwegian Sea herring fisheries underwent sharp changes, largely alternating with each other in a way that had obvious climatic as well as historical significance. The variations are outlined in Fig. 82. How far they represent migrations of the same fish stocks is not known, of course. All five of the Norwegian herring fishery periods, however, corresponded to minima in the occurrence of ice at the coasts of Iceland. In the sixteenth and seventeenth centuries the fish seem to have preferred the North Sea rather than the Norwegian coast. (The herring normally inhabit waters with temperatures between 3 and 13 °C.) Trolle was the first to note the impact on English history: the increase of deep-sea fishing was a feature of early Tudor times and helped to build up the maritime population and strength of the country. The herring had recently moved from the Baltic into the North Sea, and in the words of the later-sixteenth-century English historian, Camden: "These herrings, which in the times of our grandfathers swarmed only about Norway, now in our times..."
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... swim in great shoals round our coasts every year. Thus, in at least this aspect and perhaps in others, the Little Ice Age caused England to gain at the expense of her northern neighbours.

Similarly, the centuries we have reviewed witnessed the decline of Trondheim as a northern capital, the shift of the Norwegian court first to Oslo and the Akershus fortress and later to Copenhagen after the union of the northern kingdoms; finally in 1536 Norway ceased to exist as a separate country (until 1815). A parallel (but shorter distance) southward movement took place in Scotland and culminated in the union with England in 1707.

The prosperity of Holland in the first half of the seventeenth century also owed a good deal to the transference of the fisheries to the North Sea and Atlantic waters, as well as to an industrial revolution based on the exploitation of the windmill. The rise of Dutch sea power also had something to do with the chaos produced by the Thirty Years War in central Europe and the need to protect Dutch trading interests in troublous times. Later in the seventeenth century the prosperity declined somewhat, owing partly to the incidence of great storms and sea floods which broke the dykes as well as to poorer yields from both farming and fishing.

HARVESTS AND HEALTH IN ENGLAND

England did not altogether escape direct impacts from the development of the Little Ice Age climate, however. Hoskins's survey of English wheat harvests, mainly in the west, from 1480 to 1760 shows a few runs of terrible years, among which some in the 1550s and 1560s, 1594–7, 1692–8, as well as the years 1709, 1740 and 1756, stand out. There were notable runs of good harvests in the 1490s, 1537–48, 1685–90 and 1700–7, and a much greater proportion of good harvests from 1717 to the end of the survey.

For England the summers of 1555 and 1556 and the harvests they produced certainly came as a severe shock after the easier times that preceded them. Already in 1550, 1551 and 1554 the harvests had been mediocre or worse. Whether the outcome should be described as famine is debatable, but presumably malnutrition aggravated the influenza epidemic of 1557–8 in which whole families died. A close study of the registers of births, marriages and deaths in a sample parish, Colyton (near Exeter) in southwest England, provides a survey of its population from about 1550 onwards. There was a decline in the 1550s, when deaths exceeded the number of births for several years. Thereafter, there was fairly steady growth until the last plague epidemic in the area in the 1640s reduced the population by about 20 per cent in a single year. But afterwards, apart from a spurt of marriages in the 1650s, there was no real recovery for a long time. The yearly number of burials exceeded the births from the 1660s until...
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about 1730. Only after the 1780s were the births substantially in excess. Delay of the marriage age and a general loss of fertility seem to have been the order of the day. From 1560 to 1645 the average age of the women of the parish at marriage had been 27, then until after 1700 it was 30 years. After 1720 it began to fall: the long-term average around 1800 was 25 and in the 1830s it had fallen to 23 years. Whatever the exact causes of these changes in this agricultural parish, with its small market town and involvement in the woollen industry, the numbers of the population and the expectation of life show an obvious and direct association with what we believe to have been the variations of prevailing temperature, apart from the plague of the 1640s.

THE VARIABILITY OF WEATHER IN THE LITTLE ICE AGE

The difficulties imposed by the climate in the Little Ice Age time were not only due to the lower temperatures, to which any generation could no doubt adapt, even if with some effects on health, fertility, length of life, etc. But, as the harvest results mentioned in the last two paragraphs have implied, there was an enhanced variability of the temperature level, which must have badly upset harvest expectations and posed a need for storage of reserves of foodstuffs beyond the resources of the community at that time. This was not just an occasionally very wide variability from year to year but, doubtless with more distressing effects, the wide differences between one group of up to six or eight years and the next. This is a characteristic which seems to have recurred in recent years. The well-known occurrence of very hot summer weather in the two summers of 1665 and 1666, when London experienced its last great epidemic of the plague which ended with the great fire that burnt the city in September 1666, occurred in the middle of the coldest century of the last millennium; this inevitably now arouses memories of the summers of 1975 and 1976. Similarly, the two winters with least Baltic ice as shown by the over four hundred years long record of ice closing the port of Riga occurred in 1651-2 and 1652-3; the winter of 1658-9 produced the opposite extreme – much as the great Baltic ice winters of 1962-3 and 1965-6 occurred only a few years before the ice-free winter of 1974-5. This tendency can be illustrated also by the listing of the most extreme winters and summers shown by the temperatures measured in England since 1659, in tables 2 and 3 below. Notice particularly the occurrences of opposite extremes within a few years of each other in the Little Ice Age, in the winters of the 1680s, 1690s and the 1790s, and in the summers of the 1670s and around 1720.

The temperature values quoted in tables 2 and 3 are from the series painstakingly homogenized by the late Professor Gordon Manley.
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Table 2 Average temperatures over December, January and February in the seven coldest and seven mildest winters in central England between 1659 and 1979 (long-term average for winter 1850–1850 4.0 °C)

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>-1.2</td>
<td>-0.4</td>
<td>-0.3</td>
<td>+0.4</td>
<td>+0.5</td>
<td>+0.7</td>
<td>+0.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>6.8</td>
<td>6.5</td>
<td>6.3</td>
<td>6.3</td>
<td>6.2</td>
<td>6.1</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Some of the gentry who had taken over the former monastic estates in England after the Reformation were encouraged by some of the warmer summers of the late sixteenth to eighteenth centuries to try once more establishing vineyards, as the monks had done in the high Middle Ages, though protected by specially built walled gardens and not in the open field as of old. However, when Samuel Pepys went in July-August 1661 to see one of the grandest of them, the vineyard which the Cecils had established fifty years earlier at Hatfield House, he remarked only on the coldness of the day and the size of the gooseberries.

Table 3 Average temperatures over June, July and August in the fourteen hottest and fifteen coldest summers in central England between 1659 and 1979 (long-term average for summer 1850–1850 15.2 °C)

<table>
<thead>
<tr>
<th>Summer</th>
<th>1826</th>
<th>1976</th>
<th>1846</th>
<th>1781</th>
<th>1911</th>
<th>1933</th>
<th>1947</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>17.6</td>
<td>17.5</td>
<td>17.1</td>
<td>17.0</td>
<td>17.0</td>
<td>17.0</td>
<td>17.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer</th>
<th>1868</th>
<th>1899</th>
<th>1676</th>
<th>1975</th>
<th>1666</th>
<th>1719</th>
<th>1762</th>
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</thead>
<tbody>
<tr>
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<td>16.9</td>
<td>16.8</td>
<td>16.8</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer</th>
<th>1725</th>
<th>1695</th>
<th>1816</th>
<th>1860</th>
<th>1823</th>
<th>1674</th>
<th>1675</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>13.1</td>
<td>13.2</td>
<td>13.4</td>
<td>13.5</td>
<td>13.6</td>
<td>13.7</td>
<td>13.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer</th>
<th>1694</th>
<th>1888</th>
<th>1922</th>
<th>1812</th>
<th>1862</th>
<th>1698</th>
<th>1890</th>
<th>1920</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>13.7</td>
<td>13.7</td>
<td>13.7</td>
<td>13.8</td>
<td>13.8</td>
<td>14.0</td>
<td>14.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>

NOTABLE WINTERS AND SUMMERS IN EUROPE

The period of history with which this chapter deals was, of course, the time of the great frosts which froze the rivers of Europe (fig. 83). The River Thames was frozen over in London at least 11 times in the seventeenth century, 20-22 times between 1564–5 and 1813–14. This phenomenon in itself was probably not of very great economic importance, particularly as it...
February in the seven between 1659 and 1979
0.0 °C)

<table>
<thead>
<tr>
<th>Year</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1694-5</td>
<td>1878-9</td>
</tr>
<tr>
<td>1734</td>
<td>1934-5</td>
</tr>
</tbody>
</table>

The table shows the average temperatures for the years 1694-1878 and 1934-1979.

The Little Ice Age

Fig. 83 The frozen River Thames in London: (a) (top) in December 1675; (b) in February 1684. (The painting by Abraham Hondius in (a) is reproduced by courtesy of the Museum of London.)

In Europe

was, of course, the time (fig. 83). The River Thames in the seventeenth century. This phenomenon in contrast, particularly as it...
CLIMATE, HISTORY AND THE MODERN WORLD

came to be an expected norm and society was adjusted to it. Nevertheless, the careful records that were kept of when the Dutch canals were closed to traffic because of ice have made it possible to reconstruct the prevailing winter temperatures in the Netherlands back to 1634. The series confirms the very low winter temperatures between 1670 and 1700, but suggests that in the Netherlands – more than in England – the coldness of the seventeenth century winters was fully matched for some decades around 1800. The long-term average winter temperatures for central England between 1670 and 1700 suggest that the normal yearly number of days with snow lying must have been 20–30 as against the 2–10 days which has characterized much of the present century. In the extreme cases of the seventeenth century we have a few reports of much greater totals: 60–70 days at Aldenham in 1662–3, about 80 days at Buckland (also in Hertfordshire) in 1783–4 and 102 days at another point in southern England in 1657–8. These may be compared with the general experience of between 50 and 65 days in 1962–3 and about 40 days in 1978–9. The great winter of 1683–4 was also remarkable for the recorded fact that the ground was frozen to a depth of nearly 4 ft (more than 1 m) where it was snow-free in southwest England (Somerset). In 1683–4 also belts of sea ice 5 km broad appeared along the Channel coasts of southeast England and France; at the North Sea coast of the Netherlands the ice belt is believed to have been 30–40 km broad (see also pp. 238–40). Shipping was halted, as in the Baltic. Similar conditions probably occurred in the winter of 1697–8.

The lowered summer temperatures in and around the 1690s were probably more important economically than the severity of the winters. We have reported the failures of the harvest in Scotland in those years and the similar difficulties in Norway and Switzerland. In England the growing season was presumably shortened on the long-term (30–50 years) average by about 5 weeks in comparison with the warmest decades of the twentieth century, and the yearly total accumulation of summer warmth for the crops correspondingly reduced. In the coldest individual years such as 1695, 1725, 1740 and 1816, when spring, summer and autumn temperatures were low and the summer months mostly about 20 °C (36 °F) or more below the modern normal, the growing season was probably shortened by two months or even rather more. The effects on crops in the lowland countries of Europe, particularly the continent's main 'breadbaskets' on the eastern part of the great plain in Poland and Russia, and in France, seem not to have been by any means as serious as in the uplands, but in 1695 the harvest failure was more general and from 1695 to 1697 there was famine in eastern Europe, e.g. Estonia.

There is an apparent anomaly in that the years between 1680 and 1720 saw the first great growth of merchant shipping in Norway, the first steps to that country's later possession of one of the biggest merchant fleets in the world. It seems from the local histories recorded around the coasts of southern Norway decision of coast and their timber and

The impression climate made in the influence Elder, which in that winter, w 1430s. that he This may have case an image the picture ratio went on to p four seasons o illustrated in
Biology and Engineering of Animal Wastewater Lagoons

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Biological and Agricultural Engineering Department
University of California, Davis
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Introduction

Wastewater treatment lagoons are earthen impoundments that are engineered and constructed to treat as well as temporarily store wastewater. In practice, the terms lagoons and ponds are used interchangeably. The wastewater treatment lagoons are different from wastewater storage or holding lagoons in that they are designed to function as biological reactors that allow effective degradation of organic compounds contained in the wastewater by various microorganisms. Through the biodegradation process, solid particles in the wastewater are broken down and liquified, and organic compounds are converted into inorganic compounds, resulting a reduced organic content in the wastewater effluent. Meanwhile, organic nutrients, such as nitrogen and phosphorus, are mineralized into inorganic nutrients in the forms of ammonia and orthophosphate, respectively. If designed and operated properly, treatment lagoons are capable of achieving significant reduction of suspended solids and mineralization of nutrients in the wastewater, which is desirable for wastewater irrigation and reuse.

The physical, chemical, and biological environments in the treatment lagoons are controlled to achieve the intended purposes of wastewater treatment. Depending on the specific designs, some treatment lagoons are built with wastewater storage volumes as well as treatment volumes. In comparison, wastewater storage lagoons are designed only to provide the temporary storage of wastewater. Even though natural degradation of the wastewater by indigenous microorganisms does occur during the storage period, the waste degradation rate in a storage lagoon is not controlled, and therefore degradation is less efficient and often unpredictable. Treatment lagoons are not pumped down below their treatment volume elevation except for maintenance purposes whereas storage lagoons are emptied regularly when the wastewater is pumped out for irrigation.

Wastewater treatment lagoons have been widely used for the treatment of human, industrial, and animal wastewaters due to their low capital costs and simple operational and maintenance requirements compared with other biological treatment systems. In the United States, use of treatment lagoons for human waste has the longest history, about 100 years. At present, the lagoons are mainly used in small community and rural areas where sufficient land areas are available. Animal wastewater lagoons have about 30 years of history. Early animal wastewater lagoons were designed primarily based on the experiences with human wastewater lagoons. After years of experimental evaluations, agricultural engineers and scientists have gained a better understanding of the biochemistry involved and have developed engineering design standards specific to animal wastewater lagoons. Due to the high contents of nutrients and organics in the animal wastewater, the treatment capacity of wastewater lagoons is often limited, and effluent from the lagoons is not suitable for direct discharge into surface waters. In this paper, I will discuss the biology/biochemistry and the engineering designs of animal wastewater lagoons.
Biology/Biochemistry of Wastewater Lagoons

Wastewater treatment lagoons range in depth from shallow to deep and often are categorized by their mode of biodegradation, as determined by the presence or absence of dissolved oxygen (aerobic or anaerobic), source of oxygen, and other design features. Biological degradation and sedimentation are the primary means for removal of organic and inorganic compounds from the wastewater in the lagoons. Based on the presence of oxygen, the lagoons are classified as aerobic, anaerobic, and facultative lagoons. Bacteria are the primary microorganisms responsible for waste degradation in all types of lagoons. Algae live symbiotically with bacteria in aerobic and facultative lagoons and play an important role in removing nutrients from the wastewater.

Aerobic lagoons

Aerobic lagoons contain dissolved oxygen in the water to sustain aerobic bacteria. The dissolved oxygen can be supplied naturally or artificially. Natural aeration is achieved by air diffusion at the water surface, by wind- or thermal gradient-induced mixing, and by photosynthesis. The photosynthetic microorganisms include algae and cyanobacteria (blue-green algae). Artificial aeration is achieved by mechanical aeration. Thus, there are two types of aerobic lagoons, naturally aerated lagoons and mechanically aerated lagoons.

Naturally aerated lagoons are quite shallow, typically 1 to 2 feet, to allow sunlight to penetrate the full lagoon depth to maintain active algal photosynthetic activity during daylight hours. The oxygen produced from the photosynthesis process is used by aerobic bacteria to degrade the organic waste. The dissolved oxygen level in the lagoon increases and decreases throughout the day, depending on the solar irradiation available. The general chemical reaction for aerobic degradation of organic compounds is as follows:

\[ \text{Organics compounds (C, H, O, N, S)} + O_2 \rightarrow CO_2 + H_2O + NH_4^+ \ (\text{or} \ NO_3^-) + S \ (\text{or} \ SO_4^{2-}) \]

Natural air diffusion and algal photosynthesis require that naturally aerated lagoons be shallow and have large surface areas. Mechanically aerated lagoons (Figure 1), however, do not have the depth requirement. They are usually built with much more depth and a smaller surface areas than the naturally aerated lagoons. Since oxygen is supplied through mechanical means, algal photosynthesis in the mechanically aerated lagoons plays an insignificant role.

Under aerobic conditions, the nitrogenous compounds (proteins, peptides, and amino acids) are first converted to ammonium (NH_4^+) by heterotrophic bacteria. If sufficient oxygen is available and the chemical environment is right, nitrification bacteria may be established and oxidize ammonium into nitrite and then into nitrate. Therefore, the end products of nitrogen oxidation can be ammonium, nitrite, or nitrate, depending on how complete the oxidation is carried out by the bacteria. Organic carbon is oxidized into carbon dioxide. Sulfur compounds (sulfur-containing protein) in the wastes are converted to elemental sulfur (S) or sulfate (SO_4^{2-}) in the aerobic environment instead of odor-causing sulfides in the anaerobic environment. The degree of oxidation depends on the amount of oxygen provided and the reaction time allowed in the treatment process.
Facultative lagoons

The facultative lagoons are deeper than aerobic lagoons, varying in depth from 5 to 8 feet. Waste is treated by bacterial action occurring in an upper aerobic layer, a facultative middle layer, and a lower anaerobic layer. Aerobic bacteria degrade the waste in the upper layer where oxygen is provided by natural surface aeration and algal photosynthesis. Settleable solids are deposited on the lagoon bottom and degraded by anaerobic bacteria. The facultative bacteria in the middle layer degrade the waste aerobically whenever dissolved oxygen is present and anaerobically otherwise. Figure 2 shows microbial interactions and waste degradation pathways in a facultative lagoon. The facultative lagoons are more common than naturally aerated lagoons. They have more depth and smaller surface areas but still have good odor control capabilities because of the presence of the upper aerobic layer, where odorous compounds such as sulfides produced by the anaerobic degradation in the lower layer, are oxidized before emission into the atmosphere. Biochemical reactions in the facultative lagoons are a combination of aerobic and anaerobic degradation reactions.
Anaerobic lagoons

Anaerobic lagoons are used mostly for high-strength wastewater treatment, such as animal wastewater. They vary in depth from 8 to 30 feet and are built as deep as the local geography allows to minimize the surface area and reduce odor emissions. The top layer may contain dissolved oxygen depending on wind, temperature, and organic loading rate. In general, however, the aerobic layer is very thin, less than 50 cm. and the contribution of aerobic bacteria to the overall waste degradation is insignificant. Due to the high organic content of animal wastewater, all the primary lagoons used for animal wastewater treatment are essentially anaerobic lagoons, unless mechanical aeration is added to artificially render the lagoons facultative or aerobic.

Under anaerobic conditions, two distinct reactions occur. In stage one, hydrolysis of organic compounds and conversion to intermediate organic acids are achieved by acid-forming bacteria called acidogens. Then in stage two, the organic acids are converted by methane and carbon dioxide by methane-forming bacteria called methanogens as illustrated in Figure 3.
Figure 3. Degradation of organic compounds in anaerobic lagoons (adapted from NZAEI, 1984).

The overall complete reaction of anaerobic degradation is:

$$\text{Organics}(C, H, O, N, S) \rightarrow \text{CH}_4 + \text{CO}_2 + \text{NH}_4^+ + \text{H}_2\text{S}$$

Methane ($\text{CH}_4$) and carbon dioxide ($\text{CO}_2$) are produced as the end products of organic carbon degradation. Methane has very low solubility in water and is readily emitted into the atmosphere as soon as it is formed. Ammonium ($\text{NH}_4^+$) and hydrogen sulfide are the end products of nitrogen and sulfur degradation, respectively. Ammonium ($\text{NH}_4^+$) exists in equilibrium with ammonia ($\text{NH}_3$) in the wastewater. Carbon dioxide, ammonia, and hydrogen sulfide are three soluble gases. Their potential for emission into the atmosphere is largely dependent on the pH and temperature of the lagoon water. A high pH (>8) favors more ammonia emissions while a low pH (<6) favors more hydrogen sulfide and carbon dioxide emissions. Between the two major groups of anaerobic bacteria (acidogens and methanogens), methanogens are more environmentally sensitive and fastidious. They have stricter pH and redox potential requirements. They are obligate anaerobes, i.e., they can not tolerate any molecular or ionic oxygen in the water. The redox potential of water must be below -300 for the methanogens to thrive. The optimum pH for methanogens is 6.8 to 7.5, with the lowest pH being 6.2. In comparison, acidogens are more versatile and have much wider working pH range, 5 to 8, with the optimum level being 5 to 6. Therefore, one way to suppress the methane production in anaerobic lagoons is to control the pH below 6.2. However, when methanogens are suppressed, the anaerobic degradation will not be carried to completion, yielding much organic acids that may cause strong odor problems. Volatile fatty acid (VFA) in the lagoon water has been used by researchers as an indicator for measuring how complete the anaerobic degradation is in anaerobic digesters and lagoons and for correlation with odor levels. A well functioning anaerobic digester usually has a VFA below 800 mg/L. In comparison, a heavily loaded anaerobic lagoon can have a VFA above 3,000 mg/L. The exact correlation of VFA with odor level from anaerobic lagoons has not been well established by researchers. It is currently a researchable question.

In most anaerobic lagoons, anaerobic degradation is not complete due to the fact that conditions such as organic loading rate, temperature, and retention time are not optimum for bacterial reactions. High concentrations of intermediate degradation compounds, such as organic acids,
amino acids, aldehydes, sulfides and others are present in the lagoon water and contribute most of the foul odors. Well-designed and operated lagoons can effectively lower the concentrations of these odorous compounds and keep odors to a minimum. However, high emissions of methane from open lagoons may be expected. Gases produced at the bottom of anaerobic lagoons often lift sludge to the top surface forming a layer of floating solids. Adding gentle mechanical mixing in the anaerobic lagoons has been found to help prevent this solids-rising phenomena (Rice, 1977). Covering lagoons is a good way to recover the methane gas as a fuel and also to control emissions of ammonia and other odorous gases.

In addition to acidogens and methanogens, other types of bacteria also live in the anaerobic lagoons. One with particular environmental significance is purple sulfur bacteria. Lagoons containing such bacteria turn pink, purple, or red in the warm months. Purple sulfur bacteria are phototrophic anaerobic bacteria that use sunlight as an energy source and are capable of oxidizing sulfides, therefore reducing odors from anaerobic lagoons. Due to their capability of suppressing odors from the anaerobic lagoons, they have recently become the subject of research. Research is underway at several universities to understand the right conditions for growth of purple sulfur bacteria in the lagoons. The USDA-ARS and University of Nebraska researchers (Gilley et al., 2000) have found that the zinc in swine diets enhanced the growth of purple sulfur bacteria, whereas copper inhibited their growth. Temperature and solar radiation are other factors that affect the growth of purple sulfur bacteria.

Even though lagoons are generally considered to be simple treatment systems, the biology and biochemistry involved are very complex, involving many forms of biological reactions. Anaerobic lagoons are mostly suitable for treating animal wastewater. Facultative and aerobic lagoons may be used as secondary lagoons after the anaerobic lagoons to provide further biological degradation and produce relatively odor-free water for recycling and irrigation. Thus, different types of lagoons can be combined into multiple-stage lagoons to achieve the best treatment if the land area is available. Since they are operated at ambient temperature, lagoons function well only in mild or warm climates.

**Design and Engineering of Lagoons**

As mentioned earlier, lagoons are designed to be bioreactors that should provide suitable environmental conditions for microorganisms to degrade the organic wastes. Major factors affecting the performance of animal wastewater lagoons include temperature, organic loading rate, retention time, pH, and the presence of inhibitory or toxic chemicals. Ammonia is one of the chemicals that needs special consideration. At high concentrations, ammonia can become inhibitory or toxic to the bacteria in the lagoons. Generally, total ammonia nitrogen in the lagoon water should be kept under 1,500 mg/L. Therefore, animal manure needs sufficient dilution to reduce the ammonia concentration to a safe level before entering the lagoons.

Lagoons are sized based on organic loading rate or retention time. Organic loading rate and retention time are related to the temperature of the lagoons, which in turn are decided by the local climatic conditions. The allowable organic loading rate is higher for the lagoons located in warmer climates. According to the current engineering design standard published by American Society of Agricultural Engineers (ASAE) and the design method published by USDA-NRCS,
the organic loading rate of lagoons is defined as follows. For anaerobic lagoons, the organic loading rate is the volumetric loading rate of volatile solids, which is the amount of volatile solids in pounds loaded per 1,000 cubic feet of lagoon treatment volume per day (lb VS/1000 ft$^3$ day). For facultative and naturally aerated lagoons, the organic loading rate is the area-loading rate of 5-day biochemical oxygen demand (BOD$_5$), which is the amount of BOD$_5$ in pounds per acre of surface area per day (lb BOD$_5$/ac.day).

ASAE has an engineering design standard for anaerobic lagoons (ASAE, 1999). USDA-NRCS also has an engineering design standard (USDA-NRCS, 1992). Each design standard has a set of organic loading rates recommended for different regions of the United States, with higher values for warmer regions. However, the two sets of the organic loading rates show different values for the same regions. For example, for California from the south to the north, the ASAE standard recommends the maximum loading rate to be 5.5 to 4.5 lb VS/1000 ft$^3$ day, while the USDA standard recommends 6.5 to 5.5 lb VS/1000 ft$^3$ day. Since the ASAE standard is the most recent standard developed and the authors are from USDA-NRCS, it is recommended that the ASAE standard be used as the first reference. Figure 4 shows the loading rate of anaerobic lagoons for the different regions of the United States as published by ASAE. In either standard, the organic loading rate is given as the recommended maximum loading rate. The actual loading rate that should be used depends on the treatment objectives being stressed, such as maximizing pollutant reduction, reducing odors, or minimizing sludge production. The ASAE standard recommends a minimum 50-day retention time for primary anaerobic lagoons. Figure 5 shows a diagram of a single-stage anaerobic lagoon, which contains wastewater treatment volume and storage volume.

Figure 4. Loading rate of anaerobic lagoons in lb/1000 ft$^3$.day
(adapted from ASAE, 1999).
Figure 5. Anaerobic lagoon cross section (adapted from USDA-NRCS, 1992).

Two-stage anaerobic lagoons are sized based on the criteria that the first stage contains the treatment volume and the second stage contains the storage volume. Both stages must have the volumes for net precipitation and 25-year/24 hour storm on the lagoon surface and freeboard. If wastewater is recycled on the farm for manure flushing systems, a two-stage lagoons is recommended over a single-stage lagoon. The recycling wastewater should be pumped from the second-stage.

The detailed design procedures for anaerobic lagoons are given in both the ASAE Standards and USDA-NRCS Design Method. The ASAE Standards list various engineering considerations for construction of lagoons, including sitting, groundwater protection, depth, shape, earth embankment and excavation, inlet and outlet, effluent utilization, water supply, safety, and visual appearance. It also outlines the operation and maintenance procedures, such as start-up, operational depth and loading, salt build-up, crust, sludge removal, and inspection.

Design procedures for aerobic and facultative lagoons are given by USDA-NRCS method (1992). The engineering considerations for construction, operation, and maintenance are similar to anaerobic lagoons.

References

5.0 LIVESTOCK WASTE

This emission source category characterizes fugitive hydrocarbon emissions from the natural decomposition of farm animal manures. Ammonia emissions are also evaluated for this category. The specific livestock included in this emission source category are cattle, horses, sheep, poultry, and pigs.

5.1 Activity Data for Livestock Waste

Basic animal populations are available from the California Crop and Livestock Reporting Service. Activity data for beef and dairy cattle as well as the number of hogs on farms in California were taken from this data source for the year 1986. To further distinguish between dairy and beef cattle, certain assumptions were necessary. The California Crop and Livestock Reporting Service estimates there were approximately 5 million cattle in California in 1986. They do not provide an indication of what fraction of these cattle were beef or dairy. However, they do report that 1,030,000 dairy cattle and 950,000 beef cattle calved in 1986. The ratio of these two numbers was applied to the total number of cattle in California to estimate the number of beef and dairy cattle.

Poultry populations were taken from the 1982 Census of Agriculture's Poultry Inventory and Sales. Horse and sheep population data were taken from the 1982 Census of Agriculture's Sheep and Horses Inventory and Sales. Table 5-1 summarizes the livestock inventory data available for the state of California.

In the case of livestock waste, it is important to further identify the location and number of livestock in feedlots. Feedlots represent a concentrated emission source in comparison to livestock kept on pasture or rangeland. The Bureau of Agricultural Statistics does not tract the number of cattle on feedlots by county, only by agricultural district. According to the Bureau of Agricultural Statistics, approximately eight percent of the
<table>
<thead>
<tr>
<th></th>
<th>Number of Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cattle</strong></td>
<td></td>
</tr>
<tr>
<td>Beef cattle</td>
<td>2,400,000</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>2,600,000</td>
</tr>
<tr>
<td><strong>Poultry</strong></td>
<td></td>
</tr>
<tr>
<td>Laying hens</td>
<td>39,456,033</td>
</tr>
<tr>
<td>Broiler chickens</td>
<td>23,858,777</td>
</tr>
<tr>
<td>Turkeys</td>
<td>5,187,215</td>
</tr>
<tr>
<td>Ducks, geese, and other poultry</td>
<td>2,703</td>
</tr>
<tr>
<td><strong>Horses</strong></td>
<td></td>
</tr>
<tr>
<td>Horses</td>
<td>129,310</td>
</tr>
<tr>
<td><strong>Sheep</strong></td>
<td></td>
</tr>
<tr>
<td>Sheep and lambs</td>
<td>1,214,585</td>
</tr>
<tr>
<td><strong>Pigs</strong></td>
<td></td>
</tr>
<tr>
<td>Hogs on farms</td>
<td>145,000</td>
</tr>
</tbody>
</table>

*a* 1986 population estimates from the California Crop and Livestock Reporting Service.

*b* 1982 population estimates from the Census of Agriculture's Poultry Inventory and Sales.

*c* 1982 population estimates from the Census of Agriculture's Sheep and Horses Inventory and Sales.
cattle in the state are kept on feedlots (Akan, 1987). Imperial Valley District (comprised entirely of Imperial County) has the largest number of cattle on feedlots at 73 percent. The Bureau of Agricultural Statistics maintains similar county-by-county statistics for the other livestock.

Using Dun's Market Identifiers® (a publicly available computerized database), we identified approximately 46 cattle feedlots in the State of California. In addition, there are five and ten feedlots for hogs and sheep/goats, respectively. A complete listing from this database, or a similar one, could be used in the spatial disaggregation of livestock emissions.

5.2 Emission Factors for Livestock Waste

To refine the emission factors used in the preliminary emission estimates, a literature search was conducted at the University of California at Davis Health Sciences Library. We also contacted the staff of the Animal Science Departments of UC Davis and UC Riverside. From the various reports, studies, reviews, and telephone contacts that were pursued, we found that the following information is generally available for each livestock species:

- Mass of feces produced per animal;
- Water content of feces;
- Total solids content of feces;
- Volatile solids content of feces;
- Nitrogen content of feces;
- Ammonium (NH₄) content of feces; and
- Elemental inorganic constituents of feces.

Volatile solids is a term used in manure management to describe the total organic content of feces. Manure is placed in a muffle furnace and heated for a specific amount of time to remove all organic matter. A gravimetric analysis is then used to determine the weight of inorganic matter in the feces.
We identified no literature that described organic gas emissions from livestock excrement. A literature search that focused on odors and odor control for livestock waste could possibly identify some data that could be used to better characterize livestock organic gas emissions. In lieu of any new data, we used the same emission factors that were used to calculate the preliminary emissions estimates. These are the same emission factors used by the South Coast AQMD (Halberg, 1984).

Sufficient data were identified and used to refine the livestock ammonia emission factors. A summary of the ammonia emission factor development is presented in Table 5-2. As can be seen, we relied extensively on the data presented by Overcash (1983). Other data presented in the literature indicate similar values to those presented by Overcash and support the use of these data. Overcash presents a summary of manure characteristic data for a wide variety of species from over 400 literature references. Therefore, we chose to rely on the Overcash data because sufficient data were presented from which to calculate statistical confidence intervals.

The ammonia emission factors presented in Table 5-3 characterize the emissions that result from the natural decomposition of animal excrement. As a result of this decomposition, it was necessary to make certain assumptions regarding the percentage of total nitrogen that is converted and emitted as ammonia.

Ammonia is emitted to the atmosphere as a natural component of the nitrogen cycle. Complex organic nitrogenous compounds are decomposed to a number of simpler compounds such as amino acids. Soil bacteria and certain fungi then convert amino nitrogen to ammonia in a process known as ammonification. This ammonia can then react with carbon dioxide and water present in the soil to form ammonium salts such as ammonium carbonate. Finally, nitrification takes place where certain soil bacteria oxidize the ammonia of the ammonium salts to nitrite ($\text{NO}_2^-$) or nitrate ($\text{NO}_3^-$). This is the form in which inorganic nitrogen is utilized by higher plants.
<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Nitrogen Data Source(s)</th>
<th>Determination of NH₃ Emission Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy and Beef Cattle</td>
<td>Overcash, 1983</td>
<td>Data presented by Gasser (1980) Adriano et al. (1974) and Luebs et al. (1973) indicates that approximately 50% of nitrogen excreted from cattle is present in the urine. This nitrogen is reported to be &quot;easily&quot; converted to NH₃ within a short period time. Therefore, it was assumed that 50% of the nitrogen excreted volatilizes as NH₃.</td>
</tr>
<tr>
<td>Chickens</td>
<td>Overcash, 1983</td>
<td>Most of the nitrogen in poultry manure is in the form of uric acid, a simple organic compound that is rapidly converted to ammonia (Meek, 1975). Overcash (1983) presents data showing that 9.2% of total nitrogen is excreted as ammonium (NH₃). Therefore, it was assumed that 90% the total nitrogen excreted volatilizes as NH₃.</td>
</tr>
<tr>
<td>Turkey and other Poultry</td>
<td>Overcash, 1983</td>
<td>Total nitrogen data presented as percent of waste generation. Therefore, 96% confidence intervals were calculated for percent of nitrogen in waste and waste generation per animal. Confidence intervals were combined to yield total nitrogen excreted per animal at 96% confidence. Based on chicken data, we assumed that 90% of total nitrogen excreted volatilizes as NH₃.</td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Nitrogen Data Source(s)</th>
<th>Determination of NH₃ Emission Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs</td>
<td>Meek, 1975; Overcash, 1983; and Cass et al., 1982</td>
<td>Overcash (1983) presents data that indicates 50% of the total nitrogen volatilizes as NH₃. Therefore, the NH₃ emission factor assumes that 50% of the total nitrogen excreted volatilizes as NH₃.</td>
</tr>
<tr>
<td>Horses</td>
<td>Overcash, 1983</td>
<td>Forty percent of nitrogen excreted from horses is in urine (Overcash, 1983). Based on cattle data, nitrogen contained in the urine is easily converted to NH₃. Therefore, the emission factor for horses assumes that 40% of total nitrogen excreted volatilizes as NH₃.</td>
</tr>
<tr>
<td>Sheep</td>
<td>Overcash, 1983</td>
<td>We assumed that 50% of the nitrogen excreted volatilizes as NH₃ based on cattle, horse, and pig data.</td>
</tr>
<tr>
<td>Animal Type</td>
<td>Mean TOG Emission Factor &lt;sup&gt;a&lt;/sup&gt;</td>
<td>TOG Emission Factor Confidence Interval</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>160</td>
<td>80 - 240</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>160</td>
<td>80 - 240</td>
</tr>
<tr>
<td>Pigs</td>
<td>58</td>
<td>29 - 87</td>
</tr>
<tr>
<td>Horses</td>
<td>84</td>
<td>42 - 126</td>
</tr>
<tr>
<td>Sheep</td>
<td>12</td>
<td>6 - 18</td>
</tr>
<tr>
<td>Turkey and other Poultry</td>
<td>2.4</td>
<td>1.2 - 3.6</td>
</tr>
<tr>
<td>Broiler Chickens</td>
<td>2.4</td>
<td>1.2 - 3.6</td>
</tr>
<tr>
<td>Laying Chickens</td>
<td>2.4</td>
<td>1.2 - 3.6</td>
</tr>
</tbody>
</table>

<sup>a</sup> Source: Halberg, 1984.

<sup>b</sup> 95 percent confidence intervals based on an assumed accuracy of ± 50%.

<sup>c</sup> Source: See Table 7-11.

<sup>d</sup> Statistical confidence intervals calculated using Equation 8-5.
Ammonia accumulation in the soil depends on rate of generation at a given point, and loss of ammonia to the atmosphere. The rate of ammonia release is greatest when the manure-soil mixture is first moistened (Meek, 1975). A number of researchers have reported that ammonia emissions tend to increase during the drying of moist manure (data summarized by Luebs et al., 1973). This suggests, therefore, that ammonia emissions will be at a peak during spring and early summer as moistened manure dry out.

With the exception of livestock sheep, sufficient information was identified in the literature to estimate the percentage of total nitrogen that can be converted to ammonia. Typically, this is the nitrogen contained in urine. We then assumed that this ammonia is emitted to the atmosphere. Table 5-2 summarizes the development of the livestock emission factors; the actual factors are presented in Table 5-3. Appendix A presents the detailed calculations.

5.3 Emission Estimates For Livestock Waste

Using the activity data and emission factors described above, we calculated livestock emissions on a statewide basis (see Table 5-4). Without any specific data indicating otherwise, the TOG emissions are expected to occur evenly throughout the year with little temporal variation. Research data have shown that ammonia emissions increase after manure has been wett ed and allowed to dry. This suggests that livestock ammonia emissions in California will be greatest in the spring and early summer as moist manures dry out from the winter rains (see Section 5.2). A discussion of the relative accuracy of emission estimates is presented below.

Very little information is available regarding the accuracy of the livestock inventories. For this document, we have assumed these population estimates are accurate to within ± 25 percent (with 95 percent confidence). With respect to applicability, activity data have not been approximated by an indirect measurement technique. That is, specific information regarding livestock populations is directly available. Therefore, these population data are 100 percent applicable to the source category.

Rev. 2/1/88
5-8

000226
<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Mean TOG Emissions</th>
<th>TOG Confidence Interval</th>
<th>Mean NH₃-N Emissions</th>
<th>NH₃-N Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Cattle</td>
<td>570</td>
<td>214 - 1,068</td>
<td>460</td>
<td>290 - 668</td>
</tr>
<tr>
<td>Beef Cattle b</td>
<td>530</td>
<td>197 - 986</td>
<td>330</td>
<td>180 - 510</td>
</tr>
<tr>
<td>Pigs</td>
<td>12</td>
<td>4.5 - 22</td>
<td>8.5</td>
<td>6 - 11</td>
</tr>
<tr>
<td>Horses</td>
<td>15</td>
<td>5.3 - 26</td>
<td>9.2</td>
<td>4 - 17</td>
</tr>
<tr>
<td>Sheep</td>
<td>20</td>
<td>7.4 - 37</td>
<td>17</td>
<td>10 - 25</td>
</tr>
<tr>
<td>Laying Chickens</td>
<td>130</td>
<td>49 - 244</td>
<td>86</td>
<td>57 - 120</td>
</tr>
<tr>
<td>Broiler Chickens</td>
<td>78</td>
<td>29 - 147</td>
<td>26</td>
<td>18 - 37</td>
</tr>
<tr>
<td>Turkey and other Poultry</td>
<td>17</td>
<td>6.4 - 32</td>
<td>14</td>
<td>6.4 - 24</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,372</strong></td>
<td><strong>513 - 2,560</strong></td>
<td><strong>950</strong></td>
<td><strong>570 - 1,410</strong></td>
</tr>
</tbody>
</table>

a 90 percent confidence intervals.

b Approximately 451,000 cattle were kept on feed lots in 1986. With an estimated 2,400,000 beef cattle, approximately 19 (451,000/2,400,000) percent of these emissions, therefore, result from feed lots.
There is insufficient information available to calculate rigorous statistical confidence intervals for the TOG emission factors. The confidence intervals presented in Table 5-4 assume that the emission factors have an accuracy of ± 50 percent (with 95% confidence).

For the ammonia emission factors, confidence intervals were calculated for the total nitrogen data presented in the literature. These confidence intervals were then used in the emission calculations. The confidence intervals do not account for the assumptions regarding the percentage of total nitrogen that is converted and emitted as ammonia.

As with the activity data, the emission factors were developed for individual species with no data transfer. Therefore, the emission factors were considered 100 percent applicable.

5.4 TOG Speciation Data for Livestock Emissions

Much of the data presented in the literature for animal wastes focuses on the mass of solids produced, ammonia content, and percent volatile solids. As such, there is limited information available regarding the speciation of TOG emissions from livestock waste. Table 5-5 presents a summary of volatile compounds that have been identified in decomposing animal wastes.

The EPA's *Volatile Organic Compound Species Data Manual* (EPA, 1980) provides a profile for decomposing animal waste (see Table 5-6). We were also able to identify data that illustrate the concentrations of some volatile compounds in liquid chicken manure. These data are presented in Table 5-7. These same data reportedly resemble the TOG species emitted from pig manure (Gasser, 1980).
<table>
<thead>
<tr>
<th>Type of Animal Waste</th>
<th>Class</th>
<th>Common Name</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry, swine, cattle</td>
<td>Sulfides</td>
<td>hydrogen sulfide</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>Sulfides</td>
<td>methyl sulfide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Merceraptans</td>
<td>methyl mercaptan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ethyl mercaptan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>n-propyl mercaptan</td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>Thioethers</td>
<td>dimethyl sulfide</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>diethyl sulfide</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine, cattle</td>
<td>Inorganic</td>
<td>ammonia</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine</td>
<td>Aliphatic</td>
<td>methyl amine</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine, cattle</td>
<td>Amines</td>
<td>ethyl amine</td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>trimethyl amine</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine</td>
<td></td>
<td>triethyl amine</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>Heterocyclic amines</td>
<td>benzo(b)-pyrrols (indole)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-methyl-indole (skatole)</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine</td>
<td>Alcohols</td>
<td>ethanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>n-propanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso-propanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>n-butanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso-butanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso-pentanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aldehydes</td>
<td>formaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>acetaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>propanaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso-butanaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>heptaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>valeraldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>decaldehyde</td>
<td></td>
</tr>
<tr>
<td>Poultry, swine, cattle</td>
<td>Organic acids</td>
<td>acetic acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>propionic acid</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
<td>2-methyl propionic acid</td>
<td></td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Type of Animal Waste</th>
<th>Class</th>
<th>Common Name Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry, swine, cattle</td>
<td></td>
<td>n-butynic acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n-valeric acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iso-valeric acid</td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
<td>iso-butyric acid</td>
</tr>
<tr>
<td>Cattle</td>
<td>Acetates</td>
<td>propylacetate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n-butylic acetate</td>
</tr>
</tbody>
</table>

*Table is adopted from Ifeadi, 1972.*
**TABLE 5-6. VOC SPECIES PROFILE FOR ANIMAL WASTE DECOMPOSITION**

| Substance            | 
|----------------------|-------------------------|
| Acetone              | 2.0                     |
| Ethyl alcohol        | 2.0                     |
| Isopropyl alcohol    | 2.0                     |
| Propyl acetate       | 2.0                     |
| Ethyl amine          | 1.0                     |
| Trimethyl amine      | 1.0                     |
| Methane              | 0.05                    |
| Ethane               | 0.078                   |

Source: U.S. EPA, 1980. Data Confidence Level III - Based on data which seem reasonable and should be more or less representative of the population.

**MAR Scale**

Maximum ozone integrated reactivity
ENGINEERING DIVISION REPORT

ON

AREA SOURCE EMISSIONS FOR C/Y 1983
FROM
AGRICULTURAL LIVESTOCK WASTE

CES. NO. 66605

OCTOBER 6, 1984

BY
EARL D. HALBERG, P.E., AIR QUALITY ENGINEER II
EMISSIONS INVENTORY UNIT

Sanford M. Weiss
Director of Engineering

Deanne 2-0175
INTRODUCTION
This category is used to provide an estimate of fugitive hydrocarbon emissions from the natural decomposition of farm animal manures. This is a new source assessment category for which there are no EPA emission factors, or ARB guidelines.

Biological decomposition of animal wastes has been extensively studied as a source of fuel energy, and to assess the health effects on confined animals. 11-13 These studies primarily investigated the extraction of methane gas for fuel, or the toxic effects of the many gaseous compounds emitted from manure beds. Very little information has been published which links the evolution of Total Organic Compounds (TOC) from animal wastes to the Air Quality Assessment of a region. The estimated emissions summarized in Table III indicate a potential which may warrant a much more detailed analysis than this initial evaluation.

METHOD
The basic animal population numbers were taken from the annual reports of the Agricultural Commissions of the four counties. 1-4 Agricultural reports are generated for economic measurement and base most of their counts on head sold or head produced. These had to be modified by contacts with County Veterinarians, Farm Advisors, and Brand Inspectors to establish statistical populations, and separate animals into SoCAB or SEDAB areas. 5-10
The headcounts in Table II are the results of these inquiries and are an estimated average population.

EMISSION FACTORS

The EPA and ARB have not published any emission factors related to the Biological Decomposition of Animal Manures. Several other potential sources were investigated and found to either contain no quantitative data, or the data resulted from the use of chemical processes. One of the references had abstracts of over 100 books, reports or papers on the subject of animal wastes. The only material found to link animal wastes to non-point emissions was a report by KVB. The following emission factors were taken from that report.

TABLE I

EMISSION FACTORS FOR TOC FROM ANIMAL WASTES

<table>
<thead>
<tr>
<th></th>
<th>LBS TOC/10^3</th>
<th>TONS TOC/10^3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEAD-DAY</td>
<td>HEAD-YEAR</td>
</tr>
<tr>
<td>Cattle</td>
<td>440.5</td>
<td>80.4</td>
</tr>
<tr>
<td>Horses</td>
<td>229.3</td>
<td>41.8</td>
</tr>
<tr>
<td>Pigs</td>
<td>160.0</td>
<td>29.2</td>
</tr>
<tr>
<td>Sheep</td>
<td>33.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Chickens</td>
<td>7.0</td>
<td>1.3</td>
</tr>
</tbody>
</table>

None of the emission factors above has been verified by SCAQMD tests or analysis. The reference source quoted in the KVB Report could not be located by the SCAQMD Technical Library Staff.
ASSUMPTIONS

1. All of the organic emissions are considered non-reactive.
2. The statistical populations of farm animals are reasonably accurate and are in the proper air basins.
3. The emission factors listed in Table I are appropriate for use with the statistical populations of Table II.
4. Manures have been allowed to reach their full natural state of decomposition.
5. All manure deposited was considered without any allowance for rapid removal and commercial processing.

TEMPORAL

The emissions were considered to be uniform on an annual and weekly basis. Actual emissions would probably increase during daylight hours especially on sunny days following rain.

SAMPLE CALCULATION

The estimated emissions tabulated in Table III were calculated by the following mathematical relationship:

\[
\text{EMISSIONS} = (\text{Process Rate}) \times (\text{Emission Factor}) = \text{tons TOC/YEAR}
\]

WHERE:
- Process Rate = 1000 head (Table II)
- Emission Factor = tons TOC/1000 head/yr (Table I)

EXAMPLE: Total organic compound emissions from dairy cattle manure in the South Coast Air Basin portion of Riverside County.

PROCESS RATE = 103,000 head
EMISSION FACTOR = 80.4 tons/1000 head-year
EMISSIONS = (103,000 head) x (80.4 tons/1000 head-year) = 8281.2 tons TOC/year

The above procedure was used to calculate the emissions for all animal species by Districts and the results are tabulated in Table III.

**TABLE II.**

**STATISTICAL FARM ANIMAL POPULATION 1-10**

1983

<table>
<thead>
<tr>
<th></th>
<th>Los Angeles Co.</th>
<th>Orange Co.</th>
<th>Riverside Co.</th>
<th>San Bernardino Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SoCAB</td>
<td>SEDAB</td>
<td>SoCAB</td>
<td>SoCAB</td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>5,500</td>
<td>7,000</td>
<td>2,500</td>
<td>33,000</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>36,000</td>
<td>4,000</td>
<td>0</td>
<td>103,000</td>
</tr>
<tr>
<td>Horses</td>
<td>84,000</td>
<td>16,000</td>
<td>2,000</td>
<td>65,000</td>
</tr>
<tr>
<td>Pigs</td>
<td>6,500</td>
<td>3,500</td>
<td>-</td>
<td>1,000</td>
</tr>
<tr>
<td>Sheep &amp; Goats</td>
<td>6,000</td>
<td>67,000</td>
<td>-</td>
<td>25,000</td>
</tr>
<tr>
<td>Chickens &amp; Fowl</td>
<td>1,655,000</td>
<td>68,000</td>
<td>20,000</td>
<td>2,744,000</td>
</tr>
</tbody>
</table>

---

000236
# Emissions of Total Organic Gases from Farm Animals Wastes

**South Coast Air Quality Management District 1983**

<table>
<thead>
<tr>
<th>ANIMAL/SPECIES</th>
<th>LOS ANGELES</th>
<th>ORANGE</th>
<th>RIVERSIDE</th>
<th>SAN BERNARDINO</th>
<th>DISTRICT TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SoCAB</td>
<td>SEDAB</td>
<td>SoCAB</td>
<td>SEDAB</td>
<td>SoCAB</td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>442</td>
<td>563</td>
<td>201</td>
<td>2653</td>
<td>121</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>2894</td>
<td>322</td>
<td>0</td>
<td>8281</td>
<td>0</td>
</tr>
<tr>
<td>Horses</td>
<td>3511</td>
<td>669</td>
<td>64</td>
<td>2717</td>
<td>418</td>
</tr>
<tr>
<td>Pigs</td>
<td>190</td>
<td>102</td>
<td>0</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td>Sheep and Goats</td>
<td>37</td>
<td>409</td>
<td>0</td>
<td>151</td>
<td>0</td>
</tr>
<tr>
<td>Chickens and Fowl</td>
<td>2152</td>
<td>88</td>
<td>26</td>
<td>3567</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>9226</td>
<td>2153</td>
<td>311</td>
<td>17400</td>
<td>539</td>
</tr>
</tbody>
</table>
This report used standard practice methods and procedures throughout and concluded with what should be reasonably accurate results. The only degree of uncertainty is in the Unverifiable Emission Factors.

For purposes of comparison, one reference reported the output of a manure gasification plant as 1,000,000 ft³/day of methane from 340 tons/day of manure produced by 50,000 cattle. This converts to 163 tons/year/1000 head, or about twice the emission factor used in this report. The order of magnitude difference between the manufactured gas and that from natural decomposition indicates that the factors used may be reasonable values.
## TABLE III

EMISSIONS OF TOTAL ORGANIC GASES FROM FARM ANIMALS WASTES

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT 1987

<table>
<thead>
<tr>
<th>ANIMAL SPECIES</th>
<th>TONS/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCAB</td>
</tr>
<tr>
<td></td>
<td>UNCA</td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>217</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>382</td>
</tr>
<tr>
<td>Horses</td>
<td>3,323</td>
</tr>
<tr>
<td>Pigs</td>
<td>123</td>
</tr>
<tr>
<td>Sheep &amp; Goats</td>
<td>15</td>
</tr>
<tr>
<td>Chickens &amp; Fowl</td>
<td>1,853</td>
</tr>
<tr>
<td>TOTALS</td>
<td>5,803</td>
</tr>
<tr>
<td>GRAND TOTALS</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES

5. Mr. Knight, Los Angeles Co. Agricultural Office, El Monte, CA.
6. Dr. Haight, Orange Co. Veterinarian, Santa Ana, CA.
7. Jim Sullins, Farm Advisor, San Bernardino, CA.
10. Oel Pedro, Chief, Bureau of Livestock Identification, Sacramento, CA.
15. AP-42 U.S. Environmental Protection Agency.
CONTROL OF HYDROCARBON EMISSIONS
FROM STATIONARY SOURCES IN THE
CALIFORNIA SOUTH COAST AIR BASIN

FINAL REPORT, VOLUME I
(VOLUME II, APPENDIX)

Prepared For:
CALIFORNIA AIR RESOURCES BOARD
SACRAMENTO, CALIFORNIA

Prepared By:
H. J. TABACK
T. W. SONNICHSEN
N. BRUNETZ
J. L. STREDLER
KVB, INC.
JUNE 1978

CONTRACT ARB 5-1323

000241
2. Orchard heaters—Orchard heaters were in common use in Ventura, San Bernardino and Riverside Counties to protect the citrus orchards from frost damage. It was estimated by the Ventura APCD (Ref. 2-48) that there were approximately 22 heaters per acre in citrus growth in that county.

Organic compound emissions resulted primarily from the evaporation of fuel oil and not as a result of the combustion process (Ref. 2-4). Therefore, even if the orchard heaters were used relatively infrequently, organic compound emissions were still present any time there was standing fuel exposed to the atmosphere. Emission estimates have been made in Reference 2-48A. The summer evaporation (March through November) averaged 2 gal/heater while the winter evaporation averaged 0.25 gal/heater, for a total of 2.25 gal/heater-year.

Emission estimates for the current program were based on published figures by the local control agencies. Total emissions from these sources were estimated to be 1200 tons per year.

3. Animal wastes—The existence of methane and other components in the gas generated by the biological decomposition of animal wastes had been extensively studied. These investigations had been aimed both at the potential for energy recovery (Ref. 2-49) as was the case with landfill gases and also to assess the harmful effects of these gases on livestock production in confined areas (Ref. 2-50).

Results from a recent study (Ref. 2-51) were employed to estimate the emission rates from these sources. A summary of the calculations is presented in Table 2-34. Inventories of the livestock population for each county were obtained from the County Agricultural Reports (Ref. 2-46). For these data, it was estimated that 77 tons per day of gases from animal wastes were generated in the agricultural areas shown in Figure 2-2.

<table>
<thead>
<tr>
<th></th>
<th>Total Inventory</th>
<th>Emission Factor</th>
<th>Emissions (tons/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(10^3 Head)</td>
<td>(lb TDC/10^3 head-day)</td>
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<tr>
<td>Cattle</td>
<td>147</td>
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<td>32.4</td>
</tr>
<tr>
<td>Chickens</td>
<td>9992</td>
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<tr>
<td>Pigs</td>
<td>5</td>
<td>160.0</td>
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<tr>
<td>Horses</td>
<td>73</td>
<td>229.3</td>
<td>3.4</td>
</tr>
<tr>
<td>Sheep</td>
<td>87</td>
<td>33.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>77.6</td>
</tr>
</tbody>
</table>

2-47. Personal communication with Art Dawson, Sunkist Growers, Inc.

2-48. Personal communication with Craig Barbario, Ventura County AFCD.


2-51b. Personal communication with Dr. Ming-yu Li, University of California-Davis, Department of Food Protection and Toxicology Center.


2-54. Personal communication with E. R. Wilkinson, California Division of Oil and Gas.


2-56. Personal communication with P. R. Zimmerman, Washington State University.

2-57. Personal communication with Mike Welsh, San Bernardino National Forest.

2-58. Personal communication with David Henderson, EPA Region IX.


2-61. Personal communication with Edward Scott, Asphalt Institute, Los Angeles.
<table>
<thead>
<tr>
<th>COUNTY</th>
<th>RANK</th>
<th>LABOR FORCE</th>
<th>EMPLOYMENT</th>
<th>UNEMPLOYMENT</th>
<th>RATE</th>
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<td>490</td>
<td>450</td>
<td>40</td>
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<td>6,760</td>
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<td>LAKE</td>
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<td>10,280</td>
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<tr>
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<td>137,400</td>
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<tr>
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<td>1,362,900</td>
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<td>SAN JOAQUIN</td>
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<td>237,900</td>
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<td>SAN LUIS OBISPO</td>
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<td>115,700</td>
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<tr>
<td>SAN MATEO</td>
<td>1</td>
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<td>204,500</td>
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<tr>
<td>SANTA CLARA</td>
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<td>1,003,900</td>
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<td>252,800</td>
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<tr>
<td>-------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
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<tr>
<td>STANISLAUS</td>
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<td>18,800</td>
<td>2,500</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

NOTE: Unemployment rates are calculated from unrounded data.

NOTE: Labor force data for years prior to 1990 are not comparable with data for 1990 and later years due to the introduction of the 1990 Census population figures.

Source: State of California, Employment Development Department, Labor Market Information Division, (916) 262-2162.
United States Annual Average Labor Force Data, 1983-2000
Data are Not Seasonally Adjusted

<table>
<thead>
<tr>
<th>Year</th>
<th>Civilian Labor Force</th>
<th>Employed</th>
<th>Unemployed</th>
<th>Unemployment Rate</th>
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<tr>
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<tr>
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</tr>
<tr>
<td>1987</td>
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<td>112,440</td>
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<tr>
<td>1988</td>
<td>121,669</td>
<td>114,968</td>
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</tr>
<tr>
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<td>1990 (1)</td>
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<td>118,793</td>
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<tr>
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<tr>
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<td>129,200</td>
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<td>1994 (1)</td>
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<td>7,996</td>
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<td>132,304</td>
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<tr>
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<tr>
<td>1997 (1)</td>
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<td>131,463</td>
<td>6,210</td>
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<td>Year</td>
<td>Unemployed 16+</td>
<td>Employment 16+</td>
<td>Labor Force 16+</td>
<td>Unemployment Rate</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>----------------</td>
<td>-----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1999 (2)</td>
<td>139,368</td>
<td>133,488</td>
<td>5,880</td>
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<tr>
<td>2000</td>
<td>140,863</td>
<td>135,208</td>
<td>5,655</td>
<td>4.0</td>
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</tbody>
</table>

1. Not strictly comparable with data for prior years.
2. Beginning in January 1999, data are not strictly comparable with data for 1998 and earlier years because of the revisions in the population controls used in the household survey.

Source: US Department of Labor, Bureau of Labor Statistics

Return to Labor Market Information
PROOF OF SERVICE
CCP §§ 1011, 1013, 1013a, 2015.5; FRCP 5(b)

I am employed in the County of Kings, State of California. I am over the age of 18 years and not a party to the within action; my business address is 311 North Douty Street, Hanford, California, 93230. On September 10, 2001, at 11:45 a.m., I delivered a letter dated September 10, 2001, from Michael E. LaSalle of Griswold, LaSalle, Cobb, Dowd & Gin, L.L.P. regarding the Draft Dairy Element of the Kings County General Plan (Comments to PEIR) with Appendix attached thereto on the interested parties in this action by placing a true and correct copy thereof enclosed in a sealed envelope addressed as follows:

WILLIAM R. ZUMWALT
KINGS COUNTY PLANNING AGENCY
Kings County Government Center
1400 West Lacey Boulevard
Hanford, CA 93230

☐ (By Mail) I deposited such envelope in the mail at Hanford, California. The envelope was mailed with postage thereon fully prepaid.

☐ (By Mail) As follows: I am "readily familiar" with the firm's practice of collection and processing correspondence for mailing. Under that practice it would be deposited with the United States Postal Service on that same day with postage thereon fully prepaid at Hanford, California, in the ordinary course of business.

☐ (By Overnight Delivery) I deposited such envelope in the United Parcel Service depository at Hanford, California. The envelope was sent with delivery charges thereon fully prepaid.

☒ (By Personal Service) I caused such envelope to be hand delivered to the offices of the addressee(s) shown above.

☐ (By Facsimile) I caused each document to be delivered by electronic facsimile to the offices listed above.

☐ (State) I declare, under penalty of perjury, under the laws of the State of California,
(Federal) I declare that I am employed in the office of a member of the Bar of this Court at whose direction the service was made.

Executed on September 10, 2001, at Hanford, California.

Karen Morris
KAREN MORRIS
VIA OVERNIGHT DELIVERY

Bill Zumwalt
Director of Planning and Building Inspection
Kings County Planning Agency
Kings County Government Center
Hanford, CA 93230

Re: Draft Dairy Element of the Kings County General Plan and Program Environmental Impact Report

Dear Mr. Zumwalt:

The Sierra Club appreciates the opportunity to comment upon the Revised Draft Dairy Element of the Kings County General Plan ("Dairy Element") and Draft Program Environmental Impact Report ("PEIR") for the Dairy Element. The Sierra Club is a nonprofit corporation organized under California law, with approximately 750,000 members nationwide. The Kern-Kaweah Chapter of the Sierra Club consists of members residing in Kern and Kings Counties, California. Sierra Club is dedicated to exploring, enjoying and protecting the wild places of the Earth; to practicing and promoting the responsible use of the Earth's resources and ecosystems; to educating and enlisting humanity to protect and restore the quality of the natural and human environment; and to using all lawful means to carry out these objectives. One of the Sierra Club’s national priorities is the protection of the environment, including but not limited to the air, surface water and groundwater, from pollution by concentrated animal feeding operations ("CAFOs").

The purpose of this letter and the attached documents is to inform the Kings County Planning Agency that the PEIR for the Dairy Element fails to comply with the requirements of the California Environmental Quality Act ("CEQA"), Cal. Pub. Res. Code § 21000 et seq. (West 2001), the CEQA Guidelines, Cal. Code Regs. tit. 14, § 15000 et seq. (2001), and the Kings County Local Guidelines to Implement CEQA, Res. No. 96-048 (1996). In addition, approval of the Dairy Element would render the Kings County General Plan internally inconsistent. We urge the Planning Agency and the Board of Supervisors not to approve the Dairy Element until Kings County has fully addressed the Dairy Element’s environmental impacts in a new Program EIR, which is recirculated for public and agency review, and resolved its inconsistencies with the General Plan.
I. INTRODUCTION

The California Legislature enacted CEQA to ensure that public agencies “take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state.” Cal. Pub. Res. Code § 21001(a). Consistent with this intent, the California Supreme Court has declared that CEQA must be interpreted by the courts “to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.” Mountain Lion Found. v. Fish & Game Comm’n (1997) 16 Cal. 4th 105, 112, 939 P.2d 1280, 65 Cal. Rptr. 2d 580 (quoting Friends of Mammoth v. Board of Supervisors of Mono County (1972) 8 Cal. 3d 247, 259, 104 Cal. Rptr. 761, 502 P.2d 1049). When a project may have a significant effect on the environment, CEQA requires preparation of an Environmental Impact Report (“EIR”) “to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided.” Cal. Pub. Res. Code § 21002.1(a); CEQA Guidelines § 15064.

An EIR is especially valuable as an informational device for proposed agency actions that pose such serious threats to the environment as the Dairy Element. The County has developed the Element “as a comprehensive set of goals, objectives, and policies to guide development, expansion, and operation of milk cow (bovine) dairies within the County.” PEIR at 1-1. Even as many states, conscious of the rapidly evolving body of information regarding CAFOs, have enacted various types of moratoria on these animal factories, the Dairy Element would permit a threefold increase in the number of cows in Kings County. At full capacity, the County’s dairies would generate more than 25,000 tons of manure each day, and would emit tens of thousands of tons of air pollutants every year in a region already in serious violation of state and federal clean air standards.

As discussed in detail below, the PEIR fails to comply with CEQA in many respects, including but not limited to the following: a) the County illegally exempts future projects from environmental review under CEQA; b) the PEIR fails to achieve the higher level of analysis required of program EIRs contemplating no further environmental review; c) the PEIR fails to explain or justify the county’s decision to calculate its theoretical maximum dairy herd without considering air pollutant emissions; d) the PEIR fails to adequately disclose and analyze impacts upon air quality; e) the PEIR fails to evaluate feasible measures to mitigate significant impacts upon air quality; f) the PEIR fails to adequately describe the baseline physical conditions of the county’s water resources; g) the PEIR fails to adequately disclose and analyze impacts upon the county’s water resources; h) the PEIR fails to evaluate feasible measures to mitigate significant impacts upon water resources; i) the PEIR fails to adequately disclose and analyze impacts upon biological resources; j) the PEIR’s mitigation strategies with respect to the potential impact on biological resources are insufficient; k) the PEIR fails to adequately disclose and analyze impacts upon the county’s land use and to evaluate feasible mitigation measures; l) the PEIR fails to adequately disclose and analyze impacts upon human health; m) the PEIR fails to evaluate feasible measures to mitigate significant impacts upon human health; n) the PEIR fails to adequately disclose and analyze impacts upon the county’s public services and utilities and to evaluate feasible mitigation measures; o) the PEIR’s discussion of cumulative impacts is insufficient; and p) the PEIR’s analysis of alternatives to the Dairy Element is inadequate.
Furthermore, adoption of the Dairy Element would render the Kings County General Plan internally inconsistent. The general plan serves as the constitution for all future development within Kings County, and under Gov. Code § 65300.5, the general plan and its elements must "comprise an integrated, internally consistent and compatible statement of policies." The Dairy Element would amend the general plan, yet it is inconsistent with a number of policies and programs contained in the general plan. The requirements of the land use and resource conservation elements of the general plan have not been reconciled with the apparent inconsistencies presented by the Dairy Element, and such inconsistencies would render the proposed amendment void ab initio in the event that the County adopts it.

II. THE PEIR FAILS TO COMPLY WITH CEQA

A. The County Illegally Exempts Future Projects from Environmental Review Under CEQA.

Currently, proposals to build or expand dairies are subject to site-specific environmental review under CEQA. The Dairy Element would exempt proposed dairy projects from site-specific environmental review in most instances. According to the PEIR, site-specific environmental review would not occur because approval of such projects by the Zoning Administrator would be ministerial. This approach undermines the goals of environmental review, informed decision-making and meaningful public participation that CEQA was enacted to promote. Moreover, the PEIR's statement that the Zoning Administrator's actions in approving new and expanded dairies would be ministerial is factually and legally incorrect.

In several areas of the PEIR, the County announces that it has not addressed particular impacts of the Dairy Element, stating instead that it is deferring such analysis until specific dairy projects are proposed. For example, as discussed below, the County does not accurately describe the County’s wetlands and sensitive species, or the potential impact of the Dairy Element on these biological resources. The California Courts have emphasized that deferral of site-specific environmental assessment is acceptable only when the program EIR envisions future environmental review. *Pala Band of Mission Indians v. County of San Diego* (4th Dist. 1998) 68 Cal. App. 4th 556, 577-78, 80 Cal. Rptr. 2d 294; *Rio Vista Farm Bureau Ctr. v. County of Solano* (1st Dist. 1992), 5 Cal. App. 4th 351, 373, 7 Cal. Rptr. 2d 307; see also CEQA Guidelines § 15168(c)(1) ("When a subsequent project may result in environmental effects that were not examined in the program EIR, the agency must conduct further environmental review."). Therefore, the County must conduct site-specific review of each future dairy proposal.

The Dairy Element tries to sidestep this legal obligation by claiming that the site plan review process used to approve new or expanded dairies "is a ministerial act and is not subject to CEQA analysis." Dairy Element at DE-1. However, an agency may not exempt future projects from further environmental review simply by declaring these projects to be purely ministerial. "This argument, if valid, would eviscerate CEQA, a result clearly not intended by the Legislature. The applicability of CEQA cannot be made to depend upon the unfettered discretion of local agencies, for local agencies must act in accordance with state guidelines and the objectives of CEQA." *Day v. City of Glendale* (2d Dist. 1975) 51 Cal. App. 3d 817, 821-22,
It is not the idle pronouncement of the agency, but the nature of each subsequent project that controls whether further environmental review is required. The judicial standard of review of an agency’s decision not to prepare a later site-specific EIR is the “fair argument” standard; a court will not simply defer to an agency’s judgment. “[I]f there is substantial evidence in the record that the later project may arguably have a significant adverse effect on the environment which was not examined in the prior program EIR, doubts must be resolved in favor of environmental review and the agency must prepare a new tiered EIR, notwithstanding the existence of contrary evidence.” Sierra Club v. County of Sonoma (1st Dist. 1992) 6 Cal. App. 4th 1307, 1319, 8 Cal. Rptr. 2d 473 (emphasis added).

In this case, the County’s approval of new and expanding dairies will in most instances be discretionary decisions, for numerous reasons. First, projects that contain both ministerial and discretionary features are treated as discretionary and subject to the requirements of CEQA. CEQA Guidelines § 15268(d); Mountain Lion Found. v. Fish & Game Comm’n (1997) 16 Cal. 4th at 119, 939 P.2d 1280, 65 Cal. Rptr. 2d 580. Even where agency approval involves virtually no discretion, CEQA review is required if the approval “is the only point at which the environmental impact of the project may be publicly considered.” Glendale, 51 Cal. App. at 824.

Second, determinations that must be made “without fixed standards or objectives” are deemed to be discretionary. Glendale, 51 Cal. App. at 823; see also Friends of Westwood, Inc. v. City of Los Angeles (2d Dist. 1987) 191 Cal. App. 3d 259, 271-72, 235 Cal. Rptr. 788 (holding that “relatively general” standards made permit process discretionary). The zoning administrator (“ZA”) who will ultimately approve or deny the expansion or construction of dairies in Kings County will be faced with a mountain of complex scientific materials, with little in the way of “fixed standards or objectives” to guide his review. For example, before approving a proposed dairy project, the ZA must find that the Odor Management Plan will “[m]inimize moisture content of stockpiled manure/retained solids to a level that will reduce the potential for release of odorous compounds during storage.” Dairy Element at app. J-8. “Relatively general” standards like this one – found throughout the Element – make the ZA’s approval process discretionary.

Third, the Dairy Element provides that “[a]dditional documentation may be required prior to construction to verify that specific requirements will be included in the actual construction.” Dairy Element at app. J-3. Where, as here, the approving agency can impose “reasonable conditions” based on “professional judgment,” the approval is discretionary. Friends of Westwood, 191 Cal. App. 3d at 272 (citing Natural Resources Defense Council v. Arcata Nat’l Corp. (1st Dist. 1976) 59 Cal. App. 3d 959, 971, 131 Cal. Rptr. 172).

Fourth, the CEQA Guidelines define a “discretionary project” as one that “requires the exercise of judgment or deliberation when the public agency or body decides to approve or disapprove a particular activity . . . .” CEQA Guidelines § 15357. The sheer volume of the technical material that the ZA must review, combined with the additional responsibilities placed on the ZA by the Dairy Element, make it inconceivable that the ZA can responsibly approve or disapprove proposed dairy projects without the exercise of judgment or deliberation. The ZA
must confirm the adequacy and completeness of a Geotechnical Report, Comprehensive Nutrient Management Plan, Comprehensive Dairy Process Water Disposal Plan, Hazardous Materials Business Plan, Manure Treatment Management Plan, Odor Management Plan, Livestock Management Plan, Irrigation Management Plan, Integrated Pest Management Plan, Dead Animal Management Plan, Wildlife Survey, and Fugitive Dust Emissions Control Plan. Among other tasks, the ZA must also compare the suitability of a proposed new or expanded dairy to the various groundwater and surface water conditions (Policy DE 3.2a), compare the suitability of various types of soils to the requirements of the crops grown by the dairies (Policy DE 3.2b), and confirm that the dairy’s requirements for the distribution of wastewater ensures even distribution of nutrients over the crop area (Policy DE 3.2e). Additionally, in the ZA’s review of the Manure Treatment Management Plan, the Dairy Element requires the ZA to consult with an expert at the University of California, Davis “to determine whether the MTMP is sufficient.” Dairy Element at app. J-7. It is inconceivable that the ZA can fulfill his obligation without using judgment or deliberation.

If the Zoning Administrator’s role were truly ministerial, of course – if the ZA were expected merely to acknowledge that the requisite reports had been prepared, without any analysis of their completeness or adequacy – then the County would essentially be rubber-stamping every dairy application it received. The claims made by the dairy operators would be presumed to be accurate, and the reports required by the Element would have little value, undermining the purpose of CEQA. The responsibilities placed on the ZA under the Dairy Element plainly contemplate a role far greater than that of a “rubber stamp.”

Finally, to the extent the County relies on CEQA Guidelines §§ 15064 (b), 15064(i)(3), 15152(f)(2), and 15152(f)(3)(C) in asserting that future projects will not be subject to CEQA review, the County should be aware that the Superior Court for the County of Sacramento has invalidated these provisions. Communities for a Better Env’t v. California Resources Agency (Cal. Super. Ct. Apr. 25, 2001) No. 00CS00390, slip op. at 1-2 (attached). In response to this ruling, the California Resources Agency has advised that agencies do not rely upon the invalidated sections. California Resources Agency, CEQA Update (June 2001), at http://ceres.ca.gov/cra/CBE_notice.html. Therefore, a future dairy project may have significant effects that merit review even if the proposed project complies with the requirements of the Dairy Element. Moreover, for future dairy projects that will have significant and unavoidable impacts, the County must revisit its analysis of those effects. Communities for a Better Env’t, slip op. at 1-2.

B. The PEIR Fails to Achieve the Higher Level of Analysis Required of Program EIRs Contemplating No Further Environmental Review.

Even if the County could legally exempt all future dairy project approvals from CEQA review, the PEIR plainly lacks the rigorous analysis that would be required. An agency may dispense with the preparation of EIRs for later activities only if the program EIR “contains a thorough analysis of the relevant environmental issues and evaluates the effects of the entire program in a specific and comprehensive manner.” 1 Stephen L. Kostka & Michael H. Zischke, Practice Under the California Environmental Quality Act §11.11 (2000); see also CEQA Guidelines § 15168(c)(5). The reason for this is clear: by exempting future projects from
environmental review under CEQA, a program EIR gives the public its final opportunity to review and comment upon the impacts of all prospective projects that come within the program EIR's scope. "Such detail is required to allow for the "finely tuned and "systematic" balancing analysis' required by NEPA and CEQA . . . . A less strict approach could undermine the public review function of CEQA." Michael H. Remy et al., Guide to the California Environmental Quality Act (CEQA) 530 (10th ed. 1999).

In several critical areas, including air quality, water resources, biological resources, and human health, the PEIR's analysis is cursory and its identification of potential effects is wholly inadequate. With such deficiencies, the PEIR fails to meet the high standard that CEQA requires in order to dispense with further environmental review.

C. The PEIR Fails to Explain the County's Decision to Calculate Its Theoretical Maximum Dairy Herd Without Considering Air Pollutant Emissions.

The Dairy Element's calculation of Kings County's theoretical maximum dairy herd is critical to the PEIR's assessment of the environmental impacts generated by the Element. The Dairy Element identifies the nitrogen loading capacity of the County's farmland as the principal limiting factor, "based on the County's goal to protect water quality." Dairy Element at DE-8. Neither the Element nor the PEIR explains why emissions of harmful gases and particulate matter were not considered as limiting factors in this calculation. This information is especially relevant considering that (1) the San Joaquin Valley Air Basin is currently in non-attainment of federal and state air quality standards for ozone and particulate matter less than 10 microns in diameter ("PM10"), and (2) the PEIR ultimately identifies emissions of PM10, reactive organic gases ("ROGs"), hydrogen sulfide, ammonia, and methane as significant and unavoidable impacts on both a project level and a cumulative level. "A prejudicial abuse of discretion occurs if the failure to include relevant information precludes informed decision-making and informed public participation, thereby thwarting the statutory goals of the EIR process." Kings County Farm Bureau v. City of Hanford (5th Dist. 1990) 221 Cal. App. 3d 692, 712, 270 Cal. Rptr. 650.

D. The PEIR Fails to Adequately Disclose and Analyze Impacts Upon Air Quality.

Impacts 4.2-1, 4.2-2: Construction activities and PM10 and exhaust emissions

The PEIR fails to make a reasonable effort to quantify and analyze the emissions of PM10, ROGs, and nitrogen oxide ("NOx") that would be generated from construction activities. Under CEQA, the PEIR's primary function is as an informational document; the County and the public must be able to comprehend the extent of environmental impact before they can conclude, as the PEIR inexplicably does, that the impacts are less than significant.

A California Superior Court recently ruled that an EIR for a proposed dairy project in Kern County was inadequate for, among other reasons, failing to adequately assess the project's air quality impacts. See Center on Race, Poverty and the Env't v. County of Kern (Cal. Super. Ct. May 3, 2001) No. 242336, slip op. [hereinafter CRPEI]. A copy of the opinion is included with the letter. The court stated, "the EIR itself must detail to the extent possible the significance
of the [air pollutant] emission so that an informed public may comment upon that information.”

CRPE, slip op. at 10.

The PEIR fails to substantiate its conclusion that construction activities would have a less-than-significant impact on air quality. By merely citing policies of the Dairy Element (Policies DE 5.1d and 5.1g) that would dictate certain construction practices, the PEIR provides no information about the expected levels of emissions or the policies’ effectiveness in reducing those emissions. “A conclusory statement ‘unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind’ not only fails to crystallize issues but ‘affords no basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives.’” People v. County of Kern (5th Dist. 1974) 39 Cal. App. 3d 830, 842, 115 Cal. Rptr. 67 (quoting Silva v. Lynn (1st Cir. 1973) 482 F.2d 1282, 1285 (citations omitted)).

**PM$_{2.5}$ emissions**

Dairy operations contribute to increased levels of fine particulate matter (“PM$_{2.5}$”) in several ways, including exhaust from diesel vehicles and emission of ammonia from manure. The PEIR acknowledges that “[e]xposure to fine particulates has been linked to health problems,” PEIR at 4.2-12. However, the PEIR contains no analysis either of current levels of PM$_{2.5}$ in the San Joaquin Valley Air Basin or of the potential increase in PM$_{2.5}$ levels from new and expanded dairies. Indeed, the PEIR concedes that “the district is in the process of determining the course of action for PM$_{2.5}$.” Id. Deferral of environmental assessment to a future date directly contradicts one of the central purposes of CEQA: requiring environmental review at the earliest feasible stage in the planning process. Sundstrom v. County of Mendocino (1st Dist. 1988) 202 Cal. App. 3d 296, 307, 248 Cal. Rptr. 352; see Cal. Pub. Res. Code § 21003.1(b) (West 2001). The fact that the federal PM$_{2.5}$ standard’s legal status is uncertain should not prevent the County from attempting to quantify and analyze PM$_{2.5}$ levels in the air basin. The court in CRPE, finding that “there is no evidence to indicate that there is an inability to quantify the amount of PM$_{2.5}$ emissions,” ordered the county to estimate the quantity of PM$_{2.5}$ that would result from the project and analyze the associated health impacts. CRPE, slip op. at 9-10, 17. The absence in the PEIR of this relevant information, or evidence to indicate that there is an inability to obtain it, renders the PEIR invalid under CEQA.

**Impact 4.2-4: Operation of equipment and exhaust emissions**

The PEIR’s conclusion in this section — that the impact of emissions from the operation of equipment at new and expanded dairies is less than significant — is both legally and factually flawed. The County cannot be permitted to reach this conclusion without quantifying the expected total emissions from agricultural and dairy equipment. Instead of undertaking the required analysis, the PEIR merely states the estimated emissions of ROG, NO$_X$, and PM$_{10}$ from a single 5,000-cow dairy, and notes that these emissions would not be expected to exceed San Joaquin Valley Unified Air Pollution Control District (“SJUAPCD”) threshold levels. Instead of disclosing the impacts of a single hypothetical dairy, the PEIR should describe and analyze the collective impacts of all potential dairies that the County may contain under the Dairy Element.
Using the PEIR's estimates, a dairy of 5,000 milk cows would produce 0.3, 0.4, and 4.6 tons per year of PM_{10}, ROG, and NOx emissions from equipment exhaust, respectively. At this rate, dairies housing 244,715 milk cows (the maximum herd permitted by the Dairy Element) could be expected to generate 14.7 tons of PM_{10}, 19.6 tons of ROG, and an astonishing 225.1 tons of NOx each year. Yet these figures appear nowhere in the PEIR, violating CEQA's mandate to disclose relevant information that will serve decision-makers and the public alike. See Kings County Farm Bureau, 221 Cal. App. 3d at 712. This section must be revised to comply with CEQA and serve its informational purpose.

**Impact 4.2-10: Vehicular traffic and air pollutant emissions**

The PEIR does not quantify the potential impact of increased vehicular traffic on air quality and this provides no support for its conclusions that the impact is less than significant. "Conclusory comments in support of environmental conclusions are generally inappropriate." Laurel Heights Improvement Ass'n v. Regents of Univ. of California (1988) 47 Cal. 3d 376, 404, 764 P.2d 278, 253 Cal. Rptr. 426 [hereinafter Laurel Heights]. By stressing that the vehicular traffic associated with any individual dairy will not exceed SJVUAPCD threshold levels, the PEIR also violates CEQA by piecemealing the proposed project and omitting relevant information about the collective impact on air quality of all new and expanded dairies.

In addition, the PEIR's finding that "[t]he increase in vehicular traffic is considered to be minimal," PEIR at 4.2-77, directly contradicts its determination under Impact 4.9-1 that "[r]uck and other traffic from new dairy development . . . is a significant impact." PEIR at 4.9-7. The County should revise the PEIR to resolve this contradiction, and must discuss mitigation measures if it determines that this impact is significant.

E. The PEIR Fails to Evaluate Feasible Measures to Mitigate Significant Impacts Upon Air Quality.

In addition to the specific sections covered below, the PEIR fails to identify feasible mitigation measures for Impacts 4.2-1, 4.2-2, 4.2-4, and 4.2-10. As discussed above, the PEIR's analysis of these impacts was inadequate, and its determinations of less-than-significant impacts lack substantial evidence. Contrary to the PEIR's conclusions, several of these potential impacts are significant, compelling the PEIR to discuss feasible mitigation measures.

**Impact 4.2-3: Fugitive dust and PM_{10} emissions**

The PEIR concludes that the impact of PM_{10} emissions from fugitive dust is significant and unavoidable. However, its consideration of mitigation measures consists exclusively of a list of Dairy Element policies; the PEIR claims that "[n]o additional feasible mitigation measures are available." PEIR at 4.2-60. This cursory discussion is wholly inadequate. An EIR must describe feasible measures that could minimize significant adverse impacts. CEQA Guidelines § 15126.4. The measure described in the attached comments of Alan Gay and the attached report, Dairy Waste Pollution Reduction, are both feasible and capable of reducing dust emissions, and should therefore be adopted. One such measure would be to require new and expanded dairies to house cows in freestall barns instead of unpaved corrals. Freestall dairies would eliminate the
generation of dust that accompanies unpaved corrals. Despite noting earlier in the report that "[l]ittle to no fugitive dust would be expected to be generated from the freestall barns," PEIR at 4.2-29, the PEIR inexplicably fails to discuss or even identify prohibitions on unpaved corrals as a potential mitigation measure.

Impacts 4.2-5 to 4.2-9: Operation of dairies, adverse odors, and emissions

The PEIR’s discussion of mitigation measures for the impacts of adverse odors and emissions of ROG, ammonia, hydrogen sulfide, and methane is inadequate in several respects.

The PEIR fails to explain the reasoning behind the volatile solid ("VS") reduction standard of 50 percent established by Dairy Element Policy DE 5.1c for advanced treatment systems. The PEIR notes that Colorado requires a 60-percent VS removal efficiency. PEIR at 4.2-22. Plug flow digesters have been shown to achieve this 60-percent standard. See Gay comments at 4. Before the County settles for a weaker 50-percent standard, the PEIR must explain why mandating a 60-percent VS reduction is infeasible. "Where several measures are available to mitigate an impact, each should be discussed and the basis for selecting a particular measure should be identified." CEQA Guidelines § 15126.4(a)(1)(B) (emphasis added).

Without any empirical data or explanatory information to support the selection of this standard, the County and the public cannot properly assess the soundness of the policy, and the PEIR has not satisfied CEQA. See Kings County Farm Bureau, 221 Cal. App. 3d at 712.

The PEIR neglects to explain why it has not also set treatment standards for emitted gas reductions. The PEIR claims that “[t]reatment effectiveness currently cannot be measured by quantifying the reduction rate of the individual odorous gas compounds because of the lack of available scientific methods to do so." PEIR at 4.2-15. In fact, scientific methods are available; Mr. Gay identifies two of them in his letter. See Gay comments at 3-4. Therefore, the establishment of gas reduction standards is a feasible mitigation measure that the PEIR is required to address. See CEQA Guidelines § 15126.4(a)(1).

In addition, Policy DE 5.1c contains an exemption from the advanced treatment technology requirement for dairy expansion projects that would not involve constructing new dairy facilities, exceeding the calculated herd capacity, or exceeding SJVUAPCD threshold limits for ROG emissions. The PEIR does not analyze or explain this exemption. It is unclear from the PEIR why only ROG emissions have been selected as the keystone for the MTMP waiver. An EIR that omits relevant information precludes informed decision-making and informed public participation. See Kings County Farm Bureau, 221 Cal. App. 3d at 712. It is environmentally unsound to allow dairies to expand without consideration for the effects on existing waste treatment and disposal systems. See Gay comments at 5-6.

The PEIR also fails to consider several common best management practices currently in use at dairies to control odors from treated manure. Several of these practices, which include the planting of windbreaks and attention to winds during manure application, are summarized in the attached letter from Mr. Gay. See Gay comments at 4. The County must either require these measures or explain why they are infeasible. Cal. Pub. Res. Code § 20112.1(b).
Finally, instead of identifying a mitigation measure that will effectively reduce significant impacts upon odor and emissions, the PEIR illegally defers this responsibility. "[A]n environmental assessment, including a statement of mitigation measures, may not be deferred until a future study or project." Rio Vista Farm Bureau Ctr. v. County of Solano (1st Dist. 1992) 5 Cal. App. 4th 351, 376, 7 Cal. Rptr. 2d 307. Aerobic and anaerobic treatment systems vary in their effectiveness in preventing the emission of particular gases. Merely prescribing a VS reduction standard does not inform the public about the amount of each gas that will be emitted. Under the Dairy Element, which would eliminate environmental review of all new and expanded dairies, the public will have no opportunity to evaluate and comment on the effectiveness of treatment systems that are ultimately selected. This outcome is directly in conflict with the purpose of CEQA.

F. The PEIR Fails to Adequately Describe the Baseline Physical Conditions of the County’s Water Resources.

"An EIR must include a description of the physical environmental conditions in the vicinity of the project . . . ." CEQA Guidelines § 15125(a). Description of the environmental setting "will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant." Id. The PEIR fails to adequately describe baseline physical conditions for the county’s surface and groundwater resources.

Surface water quality is an essential component of the environmental setting, yet the PEIR contains no discussion of the current quality of surface waters in Kings County. Such a discussion is necessary for the County and the public to evaluate the impacts on surface water quality of future dairies in the County.

Similarly, the PEIR fails to establish an adequate environmental baseline for groundwater quality in the County. The PEIR must describe environmental conditions “as they exist at the time the notice of preparation is published . . . .” CEQA Guidelines § 15125(a). A current baseline for nitrogen and salt concentrations is especially important here, as the Dairy Element’s theoretical maximum dairy herd has been determined by the amount of additional nitrogen and salt that the ecosystem can absorb without contaminating groundwater. However, the PEIR relies on one source that is six years old (a 1995 U.S. Geological Survey report) and one source that is incomplete (a 1999 Kings County Planning Agency study that examined only the deeper confined aquifer). In order for the decision makers and the public to assess both the potential impact on groundwater quality and the soundness of the Dairy Element’s maximum dairy herd calculation, the PEIR must make a reasonable effort to determine and disclose the current state of groundwater quality.

G. The PEIR Fails to Adequately Disclose and Analyze Impacts Upon the County’s Water Resources.

Impact 4.3-1: Construction runoff

The PEIR does not quantify or analyze the potential impacts to water quality of runoff associated with construction activities. This section of the PEIR merely discusses the general
impacts of construction activities on water quality, without any reference to the projected activities or environmental setting in Kings County.

The PEIR also contains no explanation of how implementation of existing regulations, including Storm Water Pollution Prevention Plans ("SWPPPs") for construction activities, would reduce the potential impact to a less-than-significant level. By failing to substantiate its conclusion, the PEIR does not comply with CEQA. See County of Kern, 39 Cal. App. at 842.

**Impact 4.3-2: Modification of surface water drainage patterns and migration of runoff**

The PEIR contains no quantification or analysis of the potential impacts associated with the alteration of drainage patterns caused by the construction or expansion of dairies in the County. This section of the PEIR plunges immediately into a discussion of the policies that would reduce potential impacts, without ever identifying what those impacts might be. Without at least citing the potential environmental impacts, the PEIR cannot properly claim under CEQA that conformance with existing regulations and policies would reduce those impacts to a less-than-significant level. This section also offers no analysis of how the County reached this conclusion, which is impermissible under CEQA. See Laurel Heights, 47 Cal. 3d at 404.

In addition, the PEIR fails to explain how the County selected 150 feet as the "appropriate setback" between manured areas and wells or surface water bodies, under Policies DE 3.2c and 4.1a.2.1. The PEIR also neglects to discuss the projected effects of this setback requirement. The PEIR only notes that the setback exceeds the California Well Standards, which require a minimum setback of 100 feet between water wells and an animal enclosure. PEIR at 4.3-39. It is difficult for the County and the public to evaluate the effectiveness of this setback without any information concerning how the particular distance was chosen, or how it might reduce the migration of runoff. Furthermore, merely identifying compliance with a standard is not an adequate substitute for CEQA analysis. Communities for a Better Env't, slip op. at 1-2 (invalidating CEQA Guidelines § 15064(h)).

**Impact 4.3-4: Flooding and water quality**

The Dairy Element permits the application of manure and dairy process water within flood zones, except during flooding or threats of flooding. The PEIR fails to account for unanticipated flooding, however. It contains no discussion of the potential impacts to surface water quality that would result from the unanticipated flooding of fields where manure has previously been applied.

**Impact 4.3-5: Operation of dairies and surface water quality**

The PEIR neglects to analyze the impacts to surface water quality from atmospheric fallout of nutrients such as ammonia and nitrogen. The PEIR states only that impacts are "difficult to measure," PEIR at 4.3-21, without putting forth any evidence to suggest why measurement might be difficult. The PEIR goes on to claim that the areas receiving the highest levels of fallout — those nearest the dairies — would "in general" be in cultivated agriculture and "may benefit from the nutrient input." However, the PEIR contains no data or analysis to
support these assertions, making it difficult for either the County or the public to evaluate the PEIR’s conclusions.

The PEIR next claims, without any explanation, that the impact to surface water quality of distant water bodies from atmospheric fallout would be less than significant, because of “mitigation measures designed to reduce emissions of nitrogen-containing compounds” contained in Section 4.2 of the PEIR. PEIR at 4.3-21. However, the portion of the Air Quality section that discusses ammonia emissions, Impact 4.2-7, concludes that the potential impact upon air quality from ammonia emissions remains “significant and unavoidable,” even after implementation of identified mitigation measures. PEIR at 4.2-73. Furthermore, a growing body of scientific literature has discussed the precipitation of airborne ammonia and its effect on water quality. Abstracts that address this topic are attached to this letter.

The PEIR offers no explanation or evidentiary support for its determination that a significant impact to air quality becomes a less-than-significant impact upon surface water quality. Without this analysis, the PEIR has not served its purpose as an informational document under CEQA. See County of Kern, 39 Cal. App. at 842.

Finally, the PEIR relies in part on Policy DE 4.1b, which establishes requirements for manure management, to claim that the potential impacts to surface water quality are less than significant. Policy DE 4.1b.A requires that dairy owners use nutrient management to “prevent the application of nutrients at rates that will exceed the capacity of the soil and planned crops to assimilate nutrients, and will reduce the potential for degradation of water resources.” Neither the Dairy Element nor the PEIR identifies any guidelines or standards by which this nutrient balance is to be achieved. The CEQA Guidelines state that “[f]ormulation of mitigation measures should not be deferred until some future time” unless they “specify performance standards which would mitigate the significant effect of the project and which may be accomplished in more than one specified way.” CEQA Guidelines § 15126.4(a)(1)(B).

As a result of each of these omissions, the PEIR’s finding that implementation of existing regulations and Dairy Element policies would reduce potential impacts to surface water quality to a less-than-significant level lacks adequate support, in violation of CEQA. See Laurel Heights, 47 Cal. 3d at 404.

**Impact 4.3-6: Depletion of water resources**

In its discussion of dairy facility water use, the PEIR notes that overdraft of local groundwater supplies could result from siting new dairies in areas that, because of insufficient water supply, cannot support selected crops. The PEIR claims that the potential impact is rendered less than significant by Policy DE 3.2h, which would require a Hydrogeologic Sensitivity Assessment (“HSA”) in two areas with limited water supplies, Kettleman Plain and Sunflower Valley. However, neither the Dairy Element nor the PEIR addresses the potential of overdraft in other areas – areas that currently have adequate water supplies but in the future might become incapable of supporting crops. The PEIR should consider this impact and either explain why it is less than significant or propose feasible mitigation measures.
Furthermore, with respect to cropland water use, the PEIR does not address the potential impacts of a substantial increase in the amount of double-cropped lands within the County, which would require an increase in water use for irrigation. The PEIR admits that such an increase could potentially result in a significant impact on local groundwater supplies, but assumes that cropping patterns will remain similar to existing conditions because of the Dairy Element’s maximum herd size methodology. This conclusion presupposes, without explanation, that the only rationale for shifting to double-cropping would be to accommodate more dairy-generated manure. The PEIR ignores the possibility that dairy owners might change their cropping patterns to achieve other objectives, such as increasing the annual crop yield, improving the organic matter level of the soil, or reducing soil erosion. The PEIR fails as an informational document by neglecting to consider the potential impacts of increased double-cropping and to propose feasible mitigation measures.

**Impact 4.3-7: Increased rate of salt and nitrogen loading and groundwater quality**

The stated impetus behind the Kings County General Plan is to promote the development of large dairies, especially those seeking to relocate from the Chino Basin of southern California. PEIR at 3-2 to 3-3. It is noteworthy that the PEIR refers to the Chino Basin, which contains the highest concentration of dairies in the world, according to the attached study by the California Regional Water Quality Control Board. The Regional Board’s study chronicles the degradation of water quality in the Basin, including alarmingly high nitrate and salt levels, and describes the significant contribution of dairies to the problem. Considering the existing evidence of water contamination that results from large dairy operations, to dismiss the impact on groundwater of a potential threefold increase in the number of cows in Kings County as less than significant is insupportable. The PEIR fails to adequately assess this impact in several respects.

The PEIR does not adequately analyze the volume of seepage through the soils that line wastewater lagoons, the quantity of pollutants that would escape, or the speed at which they would reach groundwater. When a PEIR fails to include relevant information, it impairs informed decision-making and informed public participation, and a prejudicial abuse of discretion occurs. Kings County Farm Bureau, 221 Cal. App. 3d at 712. The PEIR merely refers to Policy DE 4.1a.B.2.c, which would require that the rate of seepage not exceed $1 \times 10^{-5}$ cm/s. In fact, an expert retained by the Sierra Club in connection with the proposed Borba Dairy in Kern County calculated this rate to be equivalent to 9,236 gallons per acre per day – even without any failure of the lagoons. See Kathy J. Martin, P.E., “Lagoon Seepage and Mass Loading of Pollutants: Calculations for the Borba Dairy, Kern County, California” (July 2000) (attached). Multiplying this seepage rate by the total surface area of lagoons required to accommodate the County’s theoretical maximum herd yields an astronomical seepage figure—one that would allow 230 pounds per day of nitrogen alone to infiltrate to groundwater. See Gay comments at 1. However, these figures – in a form comprehensible to the general public – appear nowhere in the Dairy Element or the PEIR. “Informed public participation” is one of the principal statutory goals of the EIR process. Kings County Farm Bureau, 221 Cal. App. 3d at 712. In its CRPE opinion, the Kern County Superior Court held that this same practice – reporting the seepage rate for a proposed dairy’s lagoons in centimeters per second – violated CEQA: “When one has to be familiar with mathematical formulas to understand significant information, the EIR does not accomplish one of its requisite goals.” CRPE, slip op. at 16 n.1.
Calculation of the volume of seepage from future lagoons is critical to the County’s and the public’s ability to understand the severe environmental impacts of the Dairy Element and analyze the sufficiency of proposed mitigation measures.

The PEIR should also have considered the possibility of mandating the use of impermeable synthetic membranes to line dairy lagoons, which would dramatically reduce impacts to groundwater. See Gay comments at 7 ("salt loading from stored wastewater would be cut 99%). The attached article from the journal Environmental Health, “Dairy Feedlot Contributions to Groundwater Contamination,” attests to the superiority of synthetic liners over clay liners.

The PEIR bases its determination of a less-than-significant impact in part on the Dairy Element policies that concern monitoring and response action. Policies DE 6.2a, 7.1b, and 8.1c provide only that, in the event a dairy exceeds its parameters, possible response actions include reductions in herd size, measures to balance nutrient management, or coordination with the dairy monitoring office "to solve problems in a timely manner." PEIR at 4.3-38. The Dairy Element should prescribe safeguards and treatment methods in the event that salinity does increase significantly. See Gay comments at 7.

Moreover, the PEIR fails to consider the cost of treatment and cleanup in the event that pollution from dairies degrades the quality of the County’s groundwater. The first of three desalters installed to remediate severe groundwater contamination in the Chino Basin cost the State of California $58.3 million, and constructing the other two desalters will raise the total price tag to approximately $100 million for installation alone. John H. Orr, Facility Ready to Start Treating Chino Basin Water, Business Press, Mar. 6, 2000, at 5. Dairy operators should be held financially responsible for the treatment or cleanup of groundwater contaminated by their operations. However, nowhere in their discussion of response measures do the Dairy Element or PEIR ensure that funds will be available to treat or clean up degraded water supplies. Without addressing this issue, the PEIR cannot properly claim that the impact on groundwater quality is less than significant. See CRPE, slip op. at 13-14 (ordering county to consider issue of remediation costs).

Finally, the PEIR claims that Policies DE 6.2a, 7.1b, and 8.1c “indicate that the Kings County Planning Agency would be empowered and willing to modify or revoke the [Site Plan Review] approval or use permit of any and all dairies operating under the Element that do not meet the requirements established by the Element to protect groundwater quality.” PEIR at 4.3-38. None of these three policies refer to modification or revocation of any agency approval or permit. Therefore, this claim lacks adequate support in violation of CEQA, as does the subsequent, cursory claim that “[t]his appears to be an appropriate mechanism for enacting change if an impact is identified.” See County of Kern, 39 Cal. App. 842.

Impact 4.3-8: Existing wells and pollutant migration to subsurface

As discussed under “Impact 4.3-2,” above, the PEIR fails to explain how the County selected 150 feet as the “appropriate setback” between manured areas and wells or surface water bodies, under Policies DE 3.2c and 4.1a.2.i. Understanding both the rationale behind this
requirement and its effect is critical to an evaluation of the PEIR’s conclusion that the potential impact of pollutant migration into wells is less than significant.

Furthermore, after observing that poorly constructed or damaged wells in the vicinity of dairies pose a threat to water quality, the PEIR declines to make a reasonable effort to assess and disclose the current state of water wells in Kings County. Instead, the County illegally defers this assessment until a proposal exists for a new or modified dairy site. The purpose of an EIR is to assess environmental impacts before a project proceeds; the PEIR’s failure to do so precludes informed decision-making and public participation. See Kings County Farm Bureau, 221 Cal. App. 3d at 712.

II. The PEIR Fails to Evaluate Feasible Measures to Mitigate Significant Impacts Upon Water Resources.

The PEIR concludes that none of the potential impacts to water resources are significant. However, as discussed above, the PEIR reaches this conclusion without establishing a current baseline for water quality, conducting an adequate analysis of the potential impacts it identifies, or addressing several additional impacts that are potentially significant. Considering these deficiencies, the PEIR’s failure to discuss feasible mitigation measures to protect water resources violates CEQA.

I. The PEIR Fails to Adequately Disclose and Analyze Impacts Upon Biological Resources.

The PEIR contains inadequate information concerning Kings County’s biological resources and thus fails in its duty to serve as the basis for informed decision-making and public policy. While the PEIR asserts that surveys of the area’s biological resources will be conducted in the future, CEQA does not permit deferral of environmental analysis to a future date. As one court explained, “an environmental review deferred is an environmental review denied.” Save Our Forests and Ranchlands v. County of San Diego, No. 676630, slip op. at 5 (Aug. 31, 2000).

The County should conduct biological surveys before it adopts the Dairy Element. Without that information, it is impossible for decision-makers and the public to apprehe the extent of the Dairy Element’s impact on those resources. See Santiago County Water District v. County of Orange 118 Cal. App. 3d 818, 831 (1981) (“an EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences.”); see also CEQA Guidelines § 15150; Stanislaus Natural Heritage Project v. County of Stanislaus 48 Cal. App. 4th 182 (1996).

A description of the environmental setting is the starting point for environmental impact analysis. The Kings County PEIR’s discussion of the environmental setting is flawed with regard to the county’s biological resources. CEQA Guideline § 15125 states that an EIR must include a discussion of both the local and regional environmental settings. Furthermore, “[s]pecial emphasis should be placed on environmental resources that are rare or unique to that region and would be affected by the project. The EIR must demonstrate that the significant
environmental impacts of the proposed project were adequately investigated and discussed and it must permit the significant effects of the project to be considered in the full environmental context.” CEQA Guidelines § 15125(c). The Kings County PEIR fails to discuss the regional environmental setting beyond the boundaries of Kings County, and its consideration of rare or unique resources is severely limited. The PEIR also relies on outdated and incomplete data.

Because the PEIR fails to adequately describe the Court’s existing biological resources, including the presence of rare and sensitive species and their habitat within the areas affected, the PEIR also fails to adequately assess the impact of the Dairy Element on those resources. For example, the PEIR states that there will be no significant impacts related to loss and modification of wetlands. However, without information about the nature and extent of wetlands within the area affected, the PEIR’s statement amounts to a bare conclusion without supporting analysis.

The PEIR illegally defers analysis of the Dairy Elements impact on wetlands. The PEIR states that when new and expanded projects are proposed, “a detailed wetland assessment would be required” to determine whether wetlands are present. By postponing the assessment to a future date, the PEIR deprives the public of information needed to apprehend the extent of the Dairy Element’s impact on wetlands.

Additionally, the PEIR illegally defers analysis of the Dairy Element’s impact on sensitive species. While the PEIR acknowledges that historic occurrences of rare, threatened, and endangered species have been reported in Kings county, the report only states that “further detailed surveys would be necessary to confirm the presence or absence of special-status animals,” without any explanation of why such studies are not included in the PEIR or why it may not be feasible to conduct such studies at present. PEIR at 4.4-5. The PEIR claims that construction and operation of dairy facilities on existing agricultural fields “would not result in significant impacts on biological resources,” yet the PEIR contains no evidence to support such a statement. In fact, the description of the kit fox habitat flatly contradicts this claim. The PEIR states that the kit fox “generally inhabit grazed, non-irrigated grasslands, but live next to and forage in tilled or fallow fields, irrigated row crops, orchards, and vineyards.” PEIR at 4.4-5. These are exactly the areas contemplated for future dairy use by the Dairy Element, and thus the PEIR’s statement that there would be no significant impacts on the kit fox is unsupported, especially since the PEIR acknowledges that the status of the kit fox within these habitats has been “poorly documented.” PEIR at 4.4-5

The PEIR also fails to explain why certain areas are to be presumptively excluded from future study of potential impacts. Dairy Element Policy DE 1.2e states that “land that has been continuously cultivated since 1985, or before, is presumed not to qualify as wetland or habitat” and also presumes that “temporarily” fallow land is presumed not to provide habitat, without defining “temporary.” The PEIR does not explain or justify these assumptions.

The PEIR section on biological resources also contains an ambiguous sentence that makes no sense. PEIR 4.4-8 reads: “The potential for occurrence of special-status species on natural habitat, or the indirect effects (e.g., additional nighttime light and glare) of potential development adjacent to sensitive habitat.” Something is missing from this sentence.
J. The PEIR Fails To Adequately Disclose and Analyze Impacts Upon Human Health.

Identification of significant environmental impacts is one of the primary purposes of the EIR and is necessary to ensure that public agencies do not approve projects if there are feasible mitigation measures available to reduce or avoid the environmental impacts. An EIR must set forth the factual and analytical bases for its conclusions and must provide reasons for a determination of insignificant impacts. Furthermore, judgments on significance of impacts must be based on scientific evidence and other evidence to the extent possible. In its analysis of the potential impacts to human health that would result from the Dairy Element, the PEIR fails to support its conclusion that impacts would be less than significant.

Impact 4.8-1: Worker exposure to hazardous materials

The PEIR finds that this is a less than significant impact because there are regulations in place that minimize agricultural workers' exposure to pesticides and other hazardous materials. However, such regulations do not apply to dairy workers, and the PEIR merely states that similar regulations would be established to protect dairy workers without explaining when or how this will occur. The PEIR also claims that the potential for dairy worker exposure to hazardous materials would be similar to that encountered by farm workers. Before claiming that the impact of exposure to hazardous materials would be rendered insignificant by regulations aimed at protecting worker safety, the County should have protective regulations in place that will minimize the particular impacts associated with the dairy industry.

The PEIR states that the Dairy Element specifically addresses the problem of worker exposure to hazardous materials, yet the language of the element merely states an objective of protecting worker health and a policy of compliance with applicable laws and regulations, without any further elaboration. Dairy Element Objective 4.3 and Policy DE 4.3a. The PEIR does not explain how this objective will be achieved.

Impact 4.8-3: Operation of dairies and increased vector activity

The PEIR claims that the impact of an increase in mosquito, fly, and rodent populations is a less than significant impact. The PEIR refers to Policy DE 4.3b of the Dairy Element, which requires development and implementation of an Integrated Pest Management Program by dairies. However, neither the PEIR nor the element makes any reference to the standards that would guide the approval of such plans. The PEIR also refers to Policy DE 4.3c, which requires dairy operators to comply with the guidelines of the Kings Mosquito Abatement District ("KMAD"), yet again, neither PEIR nor the Element assesses the adequacy of the KMAD's guidelines in light of the potential increases in vector activity. The PEIR also fails to make any projections regarding the potential increase in vector infestation that would result from expansion of dairy operations in Kings County.

Impact 4.8-4: Operation of dairies and pathogens

The PEIR fails to adequately assess the impacts of pathogen transmission and increased...
antibiotic use that would result from the Dairy Element.

Livestock manure contains many pathogenic microorganisms, and the application of these wastes to land creates the potential for environmental contamination. Protozoan pathogens may present the greatest threat to public health since they are often resistant to current methods of water treatment. A number of factors may affect the potential degree of pathogenic pollution, including soil pH, temperature, plant life, microbial surface properties, soil type and water content and flow, and slope.

The PEIR also fails to adequately consider the potential health effects of cryptosporidium parvum on dairy workers. Cryptosporidium is a protozoal parasite that is shed by humans, cattle, and other animals. It can be transmitted from animals to humans and it has a very low infectious dose for humans. Livestock shedding is usually limited to the first six months of life, though European researchers have also reported shedding of cryptosporidium in adult beef cattle. Infants and young children are especially vulnerable to cryptosporidiosis.

The PEIR recognizes that “the distances pathogens can travel in various hydrogeological environments are not well-defined,” yet the element only establishes a setback of 150 feet between wells and “potential sources of pollution.” The PEIR also does not note whether manure-covered crop areas within the NSOZs are to be included within the definition of “potential sources of pollution” or whether the definition would only apply to the dairy sites.

The PEIR does not mention the effects of antibiotic use for livestock on human health. Intensive use of antibiotics on livestock can result in the contamination of water systems. While humans generally only take antibiotics for therapeutic purposes, livestock animals are kept on steady diets of antibiotics throughout their lifespans. Large livestock operations often keep animals in crowded, dirty pens and rely on low doses of antibiotics to keep diseases at bay. Antibiotics are also regularly given to healthy animals to promote growth. Such constant dosing encourages the development of drug-resistant microbes, with the result that ever-increasing amounts of antibiotics are used. Because antibiotics are not fully metabolized in the digestive system, they end up being excreted. Discharge of antibiotic laced manure to surface and ground water may result in human exposure. The attached studies and articles highlight some of the problems associated with highly concentrated use of antibiotics within livestock populations. A recent study by the University of Illinois has traced genes resistant to the antibiotic tetracycline as far as a sixth of a mile downstream from two swine facilities that used the antibiotic to promote growth. The PEIR’s failure to assess the impact to the environment and public health of the increased antibiotic usage that would result from the increased number of cows contemplated violates the informational requirements of CEQA.

**Impact 4.8-5: Residual manure and levels of methane and nitrate**

The PEIR relies on an MTMP as a basis for its finding that exposure to residual manure is a less than significant impact. However, such reliance is misplaced, given that Policy DE 5.1c, requiring submission of MTMPs by new or expanding dairies, is itself illegally vague.
K. The PEIR Fails to Adequately Disclose and Analyze Impacts Upon the County's Public Services and Utilities and to Evaluate Feasible Mitigation Measures.

**Impact 4.10-1: Increases in water consumption**

The PEIR fails to analyze the potential impacts upon water supply in two respects. First, the PEIR does not address the potential of overdraft of water supply in an area that is currently arable but in the future might become incapable of supporting crops. Second, the PEIR neglects to consider the potential impacts of a substantial increase in the amount of double-cropped lands within the County, which would require an increase in water use for irrigation.

L. The PEIR's Discussion of Cumulative Impacts is Insufficient.

CEQA requires a discussion of the expected cumulative environmental effects produced by past, present and future projects and a reasonable analysis of the cumulative impacts. CEQA Guidelines §§ 15130(b)(2), 15130(b)(3); Kings County, 221 Cal. App. 3d at 729. In order to complete this analysis, the lead agency should "attempt in good faith to fulfill its obligation under CEQA to provide sufficient meaningful information regarding the types of activity and environmental effects that are reasonably foreseeable." Stanislaus Natural Heritage Project, 48 Cal. App. 4th at 206. The Kings County PEIR includes no such comprehensive summary of the cumulative impacts of the projected increase in Kings County dairies.

By limiting the scope of its cumulative impacts analysis to Kings County, the PEIR violates CEQA. In Kings County, supra, the Fifth District Court of Appeals rejected an EIR in which the City of Hanford had limited the scope of cumulative air quality impacts to the Mid-San Joaquin Valley instead of the entire San Joaquin Valley Air Basin. The court held that, given the reasonable availability of relevant information on the entire air basin, the limited scope of the EIR rendered it inadequate. See Kings County, 221 Cal. App. 3d at 723-24.

The Dairy Element PEIR suffers from the same deficiency pointed out in Kings County by ignoring the air quality impacts of related projects outside Kings County but within the same air basin. The County cannot excuse its failure to conduct a proper cumulative impacts analysis. Data on past, present and future dairy operations is available. The PEIR gives no reason why it would have been infeasible to collect relevant data on regional impacts from readily available sources of agricultural information, such as the USDA Extension Service, the University of California agricultural programs or the other county governments in the San Joaquin Valley Air Basin.

A county may not omit data from its cumulative impacts analysis because it feels it would be too expensive to collect. Citizens to Preserve the Ojai v. County of Ventura (1985) 176 Cal. App. 3d 421. In Citizens to Preserve the Ojai, the County relied on an outdated and incomplete air study in its analysis of cumulative impacts, claiming that it would be too costly to collect current data. The court held that the EIR was insufficient because it had omitted data that was necessary to make an informed decision, despite the cost.
Similarly, Kings County is required to conduct an analysis to make an informed decision as to the severity of the impacts from a substantial increase in the number of large-scale CAFOs. Without the factual data necessary to make an informed decision, the Kings County PEIR cannot be approved under CEQA. See Kings County, supra, 221 Cal. App. 3d at 724 ("Because the record does not provide information regarding similar energy developments in the San Joaquin Valley air basin, the agency could not, nor can we, determine whether such information would have revealed a more severe impact. Accordingly, the EIR is inadequate.")

M. The PEIR’s Analysis of Alternatives to the Draft Dairy Element is Inadequate.

The PEIR’s discussion of alternatives fails to comply with the requirements of CEQA. The PEIR discusses four alternatives: a “no project” alternative, ten percent and fifty percent reduced herd sizes, and an Increased Manure Treatment alternative. However, this discussion is inadequate in several respects. First, the range of alternatives discussed in the PEIR is insufficient. Second, the PEIR fails to analyze even its inadequate range of alternatives adequately. Third, the PEIR fails to explain why the fifty percent reduced herd size is not proposed for adoption as a feasible alternative which substantially lessens the significant impacts of the proposed project.

According to CEQA Guideline §15126.6, an EIR must “describe a range of feasible alternatives... which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives.” The PEIR fails to properly analyze alternatives that would actually reduce the adverse unavoidable impacts of the proposed Dairy Element. Except for the fifty percent reduced herd size alternative, none of the other proposed alternatives meet the standard of avoidance or substantial lessening of environmental impact that is required by CEQA.

Far from discussing a reasonable range of environmentally beneficial alternatives, the PEIR identifies only one, the fifty-percent herd reduction. For example, the PEIR deems the ten percent reduction in herd size to be of minimal environmental benefit and therefore unworthy of serious consideration. If the ten percent reduced herd size alternative fails to either avoid or substantially reduce the proposed projects significant effects, it should not have been included as an alternative. The County cannot discharge its CEQA duties by setting up meaningless, “straw man” alternatives that merit no detailed evaluation. A broader range of environmentally beneficial alternatives should be evaluated in a revised, recirculated PEIR.

The very truncated discussion of the comparative effects of alternatives in the PEIR further undermines the usefulness of the document. Another deficiency in the alternatives analysis results from the myriad flaws in the EIR discussed above in this letter. The data gaps and inadequacies in the PEIR’s discussion of environmental setting, impacts and mitigation carry over and limit the usefulness of the PEIR’s discussion of alternatives.
III. APPROVAL OF THE DAIRY ELEMENT WOULD RENDER THE KINGS COUNTY GENERAL PLAN INTERNALLY INCONSISTENT

Each city and county is required to adopt a long-term general plan that serves as a guiding document for future development. The intent and purpose of a general plan should be accommodation of growth without a loss of quality of life. The general plan is, "in short, a constitution for all further development." O’Loane v. O’Rourke (1965) 231 Cal. App. 774, 782, 42 Cal. Rptr. 283. The propriety of virtually any local decision affecting land use and development depends upon consistency with the applicable general plan and its elements. Although a general plan is not immutable, it "may not be trifled with lightly." Citizens of Goleta Valley v. Board of Supervisors, (1990) 52 Cal. 3d 553, 570.

General plans are subject to the requirement of internal consistency: "the general plan and elements and parts thereof comprise an integrated, internally consistent and compatible statement of policies for the adopting agency." Cal. Gov. Code § 65300.5, see also Sierra Club v. Kern County Board of Supervisors (1981) 126 Cal. App. 3d 698, 179 Cal. Rptr. 261. A city or county can adopt a specific plan to implement its general plan in a particular geographical area, Cal. Gov. Code § 65450, but the specific plan must still be consistent with the general plan. Cal. Gov. Code § 65454. Likewise, all zoning ordinances must be consistent with the general plan, Cal. Gov. Code § 65860(a), and conditional use permits must also meet the requirement of consistency. See Neighborhood Action Group for the Fifth District v. County of Calaveras (1984) 156 Cal. App. 3d 1176, 1184, 203 Cal. Rptr. 401. The proposed Dairy Element would render the Kings County general plan internally inconsistent, and as a result its adoption would violate state law.

"The law requires zoning ordinances to be consistent with the county’s general plan, and the general plan is required to be consistent within itself." Sierra Club v. Kern County Board of Supervisors, 126 Cal. App. 3d at 703. No single element of a general plan may be allowed to take precedence over the other elements. Under the applicable California Government Code Guidelines, the "internal consistency requirement" has several important implications that relate to the structure and content of a general plan: "First, it implies that all elements of the general plan have equal legal status. For instance, the land use element and the open-space element cannot contain different land use intensity standards rationalized by statements such as ‘if in any instance there is a conflict between the land use element and the open-space element, the land use element controls.’ Because the open-space element is not legally subordinate to the land use element, any conflicts between the two must be resolved within the general plan itself." Quoted in Sierra Club v. Kern County Board of Supervisors, Id. at 708.

The proposed Kings County Dairy Element is inconsistent with the County’s general plan in several respects. Such inconsistencies would render the proposed amendment void ab initio were the county to attempt to adopt it. Under CEQA, the PEIR is supposed to "discuss any inconsistencies between the proposed project and applicable general and regional plans." CEQA Guideline § 15125(b). The Dairy Element PEIR fails to discuss the inconsistencies that would result from adoption of the proposed element.
The introduction to the General Plan states that "The local economic base will likely continue its slow shift from primarily agriculture to increasing retail trade and service jobs. Job opportunities must be developed in these sectors to meet the needs of a growing local population." General Plan at I-4. One of the assumptions listed in the introduction to the General Plan is that industrial and commercial activities will grow in economic importance, even though agriculture will remain "the basic economic mainstay of the region." General Plan at I-5. Under the proposed Dairy Element, the county is insuring that dairy production will continue to be the predominant economic activity in the county. By adopting the Dairy Element, the county would be turning its back on the needs of its citizens to serve the interests of increasingly concentrated dairy operations which bring few new jobs into the community.

**Land Use Element**

The Land Use Element includes a discussion of implementation strategies for the objectives and policies of the element. Land Use Program 2 is particularly relevant for its potential disparities with the Dairy Element. Land Use Program 2 exhorts the County to "[c]onsider changing zone district boundaries, or relying more heavily on administrative review rather than on the conditional use permit process, in order to streamline the planning process. Retain the opportunity for public review and comment on potentially significant projects;" "[r]equire Conditional Use permits of all livestock concentration activities... which are now permitted, or are permitted subject to administrative approval, in agricultural zone districts;" and "[d]o not approve uses for new livestock animal concentrations or nuisance-producing agricultural service industries within areas designated "Limited Agriculture"." This program is in place to promote the broader objectives of the general plan; however, the Dairy Element would render much of Land Use Program 2 inconsistent with the Dairy Element.

Land Use Program 2 of the General Plan requires that conditional use permits be obtained for all livestock concentration activities. "Animal concentrations" are defined to include dairies. General Plan at LU-15. The Dairy Element seeks to circumvent this requirement by replacing the conditional use permit process with the ministerial site plan review (SPR). Such a substitution will not achieve the goals of the general plan to guide the future development of Kings County in an orderly manner so as to protect the health, safety, and welfare of Kings County's residents. Land Use Program 2 also insists that the opportunity for public review and comment on potentially significant projects be retained, yet the proposed Dairy Element would require the public to give up its right to participate in the future dairy review process. Id.

Land Use Program 2 also states that new livestock animal concentrations and other nuisance producing agricultural service industries should not be approved within areas designated as "Limited Agricultural" (AL) zones. General Plan at LU-15. The General Plan defines "limited agriculture" as specifically excluding animal concentrations, General Plan Glossary at xv, and "animal concentrations" are defined to include dairies. Id. Most AL areas designated in the Kings County Land Use Map (General Plan figure 3) are buffers zones separating urban and residential areas from more intensive agricultural activities. The proposed Dairy Element seeks to render the AL designation meaningless by allowing dairies to be sited in AL zones subject to conditional use permit review. The General Plan is clear on this point: there is no place for animal concentrations in areas that fall under the AL designation.
Additionally, Land Use Program 2 contains an important amendment to the zoning approvals process in Kings County. The amendment to the Zoning Ordinance eliminates the category of zoning permits granted by administrative approval. Instead, permits are to be granted under one of two review processes: Site Plan Review and Conditional Use Permits. The process for permitting is based on whether the proposed land use is subject to CEQA review: "Generally, those uses which do not require CEQA review should be processed as Site Plan Reviews, and those uses requiring CEQA review should be processed as Conditional Use Permits." General Plan at LU-15. The Dairy Element seeks to revise this general rule in a manner that will make the type of review dependent on the location of the proposed project and not on the environmental impact of the proposed land use.

Under Land Use Program 11, the County must "[p]repare an Agricultural Element to be integrated with the contents of the Land Use, Open Space, and Resource Conservation Elements." General Plan at LU-16-17. The Dairy Element states no reason why other forms of agricultural production are being ignored. If anything, the county should be required to prepare a comprehensive Agricultural Element as proposed in the General Plan rather than substituting a Dairy Element.

**Resource Conservation Element**

The proposed Dairy Element fails to take the goals and objectives of the General Plan’s Resource Conservation Element into account, and as a result adoption of the Dairy Element would make the General Plan internally inconsistent.

Kings County Flood Hazard Areas map (General Plan figure 11) depicts the county’s flood prone zones. The areas of the county most vulnerable to flooding include the Kings River floodplain and the Tulare Lake Basin. A comparison of the Flood Hazard map with the proposed Dairy Development Areas map from the PEIR (PEIR figure 3-2) shows that most of the proposed Nutrient Spreading Overlay Zones (NSOZs) correspond with the identified flood hazard areas. As noted above, the Dairy Element permits the application of manure and dairy process water within the flood zones, yet the PEIR fails to consider the potential for unanticipated flooding. Flooding in NSOZs could create potential impacts to surface water quality, and the PEIR fails to reconcile the conflict between the general plan and the proposed Dairy Element on this issue.

The Dairy Element is also deficient with regard to the county’s biological resources. According to the Conservation Element of the General Plan, the county has a duty to protect its biological resources. General Plan at RC-5. Specifically, "projects which result in adverse impacts to listed species must obtain a Fish and Game management permit" from the California Department of Fish and Game. Id. Objective 16.1 of the Conservation Element requires "that development in or adjacent to important natural plant and animal habitats be consistent with the preservation of the habitat." Id.

Policy 17b of the Conservation Element states that the county must "[u]se the [CEQA] process to assess wetland resources; require mitigation measures for development which could adversely impact a designated wetland." General Plan at RC-6. The PEIR to the proposed Dairy Element fails to adequately assess the county’s wetland resources, and as a result the county can
propose no mitigation measures, despite the potential for adverse impacts on the county's wetlands.

Resource Conservation Program 2 requires "environmental assessments to address in detail the effects of proposed projects on affected species or natural areas." General Plan at RC-10. The PEIR fails to address the such effects in any detail, and the proposed Dairy Element illegally attempts to defer such assessments to a time when new dairies would no longer be subject to the public comment and review process.

The proposed Dairy Element would also lead to inconsistencies between the Dairy Element and the Conservation Element with regards to the General Plan's designation of Scenic Areas (General Plan figure 12). When the map of the county's scenic areas is compared with the proposed Dairy Development Areas map (PEIR figure 3-2) it is clear that the proposed Dairy Element would potentially impinge on the county's designated scenic areas. In particular, the designated scenic areas along the Tule and Kings Rivers would be in conflict with the proposed DDOZ West, NSOZ 2 and NSOZ 4.

The Dairy Element's treatment of riparian environments is also problematic in light of the policies and objectives outlined in the general plan. Riparian environments include the areas surrounding streams or adjacent to other bodies of water, which offer wildlife rich sources of food, water, and shelter. Birds are particularly attracted to riparian environments, and such areas are especially vulnerable to environmental disturbances. Goal 18 of the general plan seeks to protect and manage riparian environments as valuable resources." General Plan at RC-7. Policies 18a-c are aimed at the protection of the riparian environments adjacent to the Kings River. However, according to the Dairy Element, additional dairies could be established in this biologically sensitive environment.

IV. CONCLUSION

For the foregoing reasons, we urge the County not to approve the Dairy Element until (1) a revised draft program EIR that fully complies with CEQA is prepared and recirculated, and (2) the Element is redrafted in a manner consistent with the Kings County General Plan. To proceed without adopting these measures will place the County's environment and public health at serious risk.

Respectfully submitted,

[Signature]

Aaron Isherwood
Staff Attorney
Comments of the Sierra Club on Draft Dairy Element and PEIR

INDEX OF ATTACHMENTS


5. Curriculum vitae of Alan E. Gay, P.E.


7. California Regional Water Quality Control Board, Dairies and Their Relationship to Water Quality Problems in the Chino Basin (July 1990).


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SUPERIOR COURT OF THE STATE OF CALIFORNIA  
COUNTY OF SACRAMENTO  

COMMUNITIES FOR A BETTER ENVIRONMENT, ENVIRONMENTAL PROTECTION INFORMATION CENTER, DESERT CITIZENS AGAINST POLLUTION,  
Petitioners/Plaintiffs  

v.  

CALIFORNIA RESOURCES AGENCY,  
Respondent/Defendant  

CALIFORNIA BUILDING INDUSTRY ASSOCIATION,  
Intervenors.  

[PROPOSED] JUDGMENT  
Case No. 00CS00300  

Honorable Ronald B. Robie  
Action Filed: February 16, 2000
The hearing on the merits of the Second Amended Petition for Writ of
Mandate and Complaint for Declaratory Relief filed by petitioners and plaintiffs
Communities for a Better Environment, Environmental Protection Information Center,
and Desert Citizens Against Pollution ("petitioners") was held on April 13, 2001 in
Department 41 of the Sacramento County Superior Court before the Honorable Ronald B.
Robie. Ellison Folk and Lisa Belenky appeared as counsel for petitioners Environmental
Protection Information Center and Desert Citizens Against Pollution, Richard Drury
appeared as counsel for Communities for a Better Environment, Marian E. Moe appeared
as counsel for respondent California Resources Agency ("respondent"), and John A.
Henning Jr. appeared as counsel for intervenor California Building Industry Association
("intervenor").

The Court having reviewed the record of respondent's proceedings in this
matter, the briefs submitted by counsel, and the arguments of counsel; the matters having
been submitted for decision; and the Court having granted in part and denied in part the
petition for writ of mandate and complaint for declaratory relief,

IT IS ORDERED AND ADJUDGED that:

1. Judgment granting the petition for writ of mandate be entered on
petitioners' Second Cause of Action. Judgment is so entered because the Court finds that,
on their face, sections 15064(h), 15130(b)(1)(B)(2), 15130(a)(4), 15064(i)(3),
15064(i)(4), 15152(f)(2) to the extent it incorporates 15064(i)(3) and 15064 (i)(4),
15152(f)(3)(C), and 15378(b)(5) of the Guidelines for implementation of the California
Environmental Quality Act, 14 Cal. Code Regs. § 15000, et seq. (the "CEQA
Guidelines") are not authorized by statute and are invalid. The Court finds that, on their
face, sections 15064.7, 15041, 15330, and 15332 are consistent with the authorizing
statute and are valid.

2. Judgment granting declaratory relief in part and denying it in part be
entered on petitioners' First Cause of Action. Judgment is so entered because the Court
finds and declares that, on their face, CEQA Guidelines sections 15064(h),
15130(b)(1)(B)(2), 15130(a)(4), 15064(i)(3), 15064(i)(4), 15152(f)(2) to the extent it incorporates 15064(i)(3) and 15064(i)(4), 15152(f)(3)(C), and 15378(b)(5) are not authorized by statute and are invalid. The Court finds that, on their face, sections 15064.7, 15041, 15330, and 15332 are consistent with the authorizing statute and are valid.

3. A peremptory writ of mandate directed to respondent shall issue under seal of this Court, ordering respondent to initiate proceedings to set aside CEQA Guidelines sections 15064(h), 15130(b)(1)(B)(2), 15130(a)(4), 15064(i)(3), 15064(i)(4), 15152(f)(2) to the extent it incorporates 15064(i)(3) and 15064(i)(4), 15152(f)(3)(C), and 15378(b)(5) within 70 days of the date the notice of entry of judgment is served.

4. Respondent shall file a return to the Peremptory Writ of Mandate within 30 days after completing the proceedings in paragraph 3.

5. Petitioners be awarded their costs of suit. The Court reserves jurisdiction to award attorneys' fees pursuant to any properly and timely filed motion by petitioners.

RONALD B. ROBIE
Honorable Ronald B. Robie
Judge of the Superior Court

MAY 18 2001

APPROVED AS TO FORM:

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Attorney for Petitioners/Plaintiffs
Environmental Protection Information Center,
Desert Citizens Against Pollution

ANNE SIMON
Attorney for Petitioner/Plaintiff
Communities for a Better Environment
§ 15130(b)(1)(B)(2), 15130(a)(4), 15064(i)(3), 15064(i)(4), 15152(f)(2) to the extent it incorporates 15064(i)(3) and 15064(i)(4), 15152(f)(3)(C), and 15378(b)(5) are not authorized by statute and are invalid. The Court finds that, on their face, sections 15064.7, 15041, 15330, and 15332 are consistent with the authorizing statute and are valid.

3. A peremptory writ of mandate directed to respondent shall issue under seal of this Court, ordering respondent to initiate proceedings to set aside CEQA Guidelines sections 15064(h), 15130(b)(1)(B)(2), 15130(a)(4), 15064(i)(3), 15064(i)(4), 15152(f)(2) to the extent it incorporates 15064(i)(3) and 15064(i)(4), 15152(f)(3)(C), and 15378(b)(5) within 70 days of the date the notice of entry of judgment is served.

4. Respondent shall file a return to the Peremptory Writ of Mandate within 30 days after completing the proceedings in paragraph 3:

5. Petitioners be awarded their costs of suit. The Court reserves jurisdiction to award attorneys' fees pursuant to any properly and timely filed motion by petitioners.

Date: __________________________

Honorable Ronald B. Robie
Judge of the Superior Court

APPROVED AS TO FORM:

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Desert Citizens Against Pollution

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APPROVED AS TO FORM:

MARIAN E. MOE
Attorney for Respondent/Defendant
California Resources Agency

APPROVED AS TO FORM:

JOHN A. HENNING JR.
Attorney for Intervenor
California Building Industry Association
DATE: Thursday, May 3, 2001

PRESENT: ROGER D. RANDALL, Judge

COURT MET AT: 8:30 A.M.   DEPT. 6

CLERK: C. L. ISAAC

TITLE:
CENTER ON RACE, POVERTY & THE ENVIRONMENT, MARIA CRUZ MEDINA, ET AL
SIERRA CLUB VS.

COUNTY OF KERN, BOARD OF SUPERVISORS FOR THE COUNTY OF KERN

BORBA DAIRY FARMS, ET AL
Real Parties in Interest

NATURE OF PROCEEDINGS:
PETITION FOR WRIT OF MANDAMUS & COMPLAINT FOR DECLARATORY RELIEF HERETOFORE SUBMITTED ON 2/23/01

DISPOSITION:
See copy of ruling attached and made a part hereof.

Copies mailed to counsel on this date.

MINUTES

000281
The Court, having read and considered the briefs of the parties, having reviewed the Administrative Record insofar as it is pertinent to the issues presented in this lawsuit, and being informed by the oral arguments of counsel, makes the following rulings:

I.

THE STANDING OF PETITIONERS TO SEEK RELIEF

Respondents raise two issues concerning the standing of Petitioners. First, they argue that the individually named Petitioners, Maria Cruz Medina, Frances L. Aguilar, and Maria Martinez, lack standing to bring this action because the Administrative Record demonstrates that they never appeared during any of the proceedings before the adoption of the NRM. Petitioners contend that the individual Petitioners do have standing because the Center on Race, Poverty & Environment represented "residents in the Arvin/Lamont Area," among whom were the three named individual Petitioners. However, the Administrative Record lacks any indication that the three individually named Petitioners were being represented during the course of the public comment period in this matter, and counsel at oral argument conceded that a list of individuals submitted to the Board of Supervisors did not contain the names of those individuals. Therefore, the argument of Respondents concerning those individual Petitioners is valid, and
the Court finds they do not have standing to pursue remedies via this Petition.

Respondents further argue that there are certain issues raised by virtue of this Petition which were not set forth by any of the Petitioners bringing this action. Those matters include "the adequacy of the EIR's discussion of PM_{10} impacts; the adequacy of the EIR's discussion of PM_{2.5}; mitigation measures for ammonia emissions; the issue of non-nitrogen salt loading; and expert comments regarding lagoon seepage." Petitioners cite to the record to demonstrate that the enumerated issues were in fact addressed in substance during the course of public comment on the project by themselves or others. The Court has reviewed the pertinent portions of the Administrative Record and has concluded that Respondents' objection based upon the ground that those issues were not addressed during the public comment period should be rejected.

Respondents also argue that, concerning the alleged inadequacy of the EIR's cumulative impact analysis, Petitioners had only asserted in the past that the EIR was flawed because of its lack of analysis of Kern County dairies, but now argue that the analysis should have addressed cumulative air impacts generated by all of the dairies in the eight counties which make up the San Joaquin Valley air basin. Furthermore, that the Petitioners never suggested there was a lack of discussion of a reasonable range of alternatives in the proposed EIR until the issue was raised in the Petition. As to these matters as well, the Court has reviewed the Administrative Record and concluded that there was sufficient
discussion during the course of the public comment period to justify the joinder of those issues in the present mandamus proceeding.

II.

DID THE EIR FAIL TO DESCRIBE AND ANALYZE THE CUMULATIVE IMPACTS FROM THE PROPOSED BORBA DAIRIES?

Petitioners allege that "The EIR's scope of cumulative impact analysis listed only Kern County dairies and failed to identify other sources in the region." They also complain that, to the extent that the EIR listed the 34 existing Kern County dairies and three additional recently approved dairies which have not yet been constructed, it made no effort to summarize "the expected environmental effects to be produced by these projects and a reasonable analysis of the cumulative impact" of them. Petitioners assert that rather than providing a comprehensive summary or analysis of the cumulative impacts of the existing and planned facilities, the report simply concludes there will be significant unavoidable impacts from cumulative air pollution from the dairies "but then makes excuses, saying no ready data is available on these kinds of facilities from government agencies, and therefore no assessment of the impact can be done."

Both Petitioners and Respondents rely on the language of CEQA Guidelines, Section 15130, and Respondent quotes as well from the discussion found in the Guidelines concerning section 15130, which clarifies that the cumulative impacts analysis "should include a discussion of projects under review by the Lead Agency and projects
under review by other relevant public agencies, using reasonable efforts to discover, disclose, and discuss the other related projects."

Respondents assert, however, that the paucity of available data made it difficult for the EIR to comprehensively analyze cumulative impacts with regard to the current project. They attempt to demonstrate that that is so by submitting the declaration of Kevin O'Dea, who was the project manager for the preparation of the EIR. An analysis of the efforts undertaken by Mr. O'Dea indicates that he attempted to get dairy information from the Kern County Planning Department and the Environmental Health Services Department; that he then contacted representatives of the Central Valley Regional Water Quality Control Board; and that he then contacted representatives of the California Department of Food and Agriculture Milk and Dairy Food Control Branch, all to no avail in his attempt to collect information which would allow him to do a comprehensive analysis of cumulative impacts. However, none of these sources proved helpful, for reasons set forth in his declaration.

In the meantime, however, it is apparent that much of the information for Kern County dairy herds was available to officials in the County (see AR 5057-5065). Furthermore, as was discussed during oral argument in this case, Respondents were unable to explain why they did not go to traditional sources of farm information such as the UC Extension Service Farm Advisor's office in both Kern County and the other seven counties in the southern
San Joaquin Valley to obtain the data necessary to make an appropriate analysis.

In Whitman v. Board of Supervisors (1979) 88 Cal.App.3d 397, 411, the Appellate Court said:

"We recognize that the 'sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible' and that perfection is not required (citing authority). On the other hand, the courts have favored specificity and use of detail in EIRs since "[a]" conclusory statement 'unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind' not only fails to crystallize issues (citation) but 'affords no basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives.'"

In the instant case the inadequacy of analysis of the cumulative impacts of the Borba Dairies and other existing and planned dairies in the basin rendered the EIR deficient insofar as cumulative impacts analyses were concerned.

III.
DID THE EIR'S ANALYSIS OF ALTERNATIVES VIOLATE CEQA?

Petitioners contend that the County violated CEQA because it did not analyze a reasonable range of alternatives to the project as proposed by the Borbas. Three alternatives were presented, being characterized as No Project-No Build; No Project-Planned Build-Out; and Relocated Project Alternative. The Board of Supervisors considered the alternatives and concluded: "For the reasons documented in the EIR and summarized below, the Board of Supervisors finds that adoption and implementation of the project
as approved is appropriate, and rejects each one and any combination of project alternatives as infeasible." There was no discussion regarding why other alternatives, such as a reduced size project, were not considered.

Petitioners assert that in the instant case, the range of alternatives really consisted of two possibilities: No project, divided in two parts; and a relocated project which all agreed would not in any way mitigate or minimize the environmental impacts of the project.

Respondent argues that CEQA does not demand a minimum number of alternatives be presented. "The purposes of CEQA are not aided by creating more paperwork by formulating additional infeasible alternatives, for the sole reason of having a certain number of alternatives. CEQA requires only that a reasonable range of alternatives be considered. (CEQA Guidelines, Section 15126.6(m))."

In San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus (1994) 27 Cal.App.4th 713, 735, the Court of Appeal observed:

"A major function of an EIR 'is to ensure that all reasonable alternatives to proposed projects are thoroughly assessed by the responsible official.' (Citing authority) As explained by this court: 'An EIR must describe a range of reasonable alternatives to the project or to the location of the project, which could feasibly attain the basic objectives of the project and evaluate the comparative merits of the alternatives." (Citing authority) The discussion must "focus on alternatives capable of eliminating any significant adverse environmental effects or reducing them to a level of insignificance,
even if these alternatives would impede to some degree the attainment of the project objectives, or would be more costly." (Citing authority) This discussion of alternatives must be 'meaningful' and must 'contain analysis sufficient to allow informed decision making.' (Citing Authority)

While it is certainly true that nothing in the CEQA or its guidelines requires that a minimum number of alternatives to a project be discussed, it is also true that the discussion of alternatives must include a discussion of feasible alternatives. In the instant case, the Board of Supervisors did not deal with or discuss in any way alternatives other than the required No Project analysis and the Relocated Project Alternative, nor did it supply any reasons why consideration of other possible alternatives might have been discarded.

Petitioners urge the inadequacy of the treatment of alternatives herein because, inter alia, the EIR failed to discuss the possibility of a reduction in size of the project. Respondents point out that the EIR properly responded to comments suggesting a reduction in the size of the project and that the response was "... that a reduced hard size was considered in developing the alternatives for the EIR." While conceding that a reduced size could create environmental gains, Respondent argues that even so "PM_{10} and ROG emissions would remain significant and unavoidable even with a significant hard size reductions (sic)." Respondents appear to be arguing that, unless a reduction in hard size would eliminate negative environmental impacts, there was no need to consider the possibility of a reduced project. In fact, that is
not the law. The law requires that alternatives to the project which would mitigate or alleviate the impact on the environment must be explored so long as they are feasible. From the record before the Court in this matter, there is no demonstration that the feasibility of a reduced herd size model was explored in this case. "Feasible means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social and technological factors."

(CEQA Guidelines, section 15364)

While the Board of Supervisors stated that it did consider a reduced herd size alternative, and discussed it in response to Comment 12-55, it then simply concluded that, although a reduction in herd size would result in a reduction in environmental impacts: "...the impact of PM₁₀ and reactive organic gas emissions would remain significant and unavoidable in both of these cases (different herd size reductions) and neither alternative would meet the primary objectives of the applicants." Absent any evidence which demonstrates why a reduction of herd size would defeat the primary objectives of the applicants, there is no evidentiary authority for the conclusion drawn by the Board.

IV.

WAS THE ANALYSIS OF AIR QUALITY IMPACTS CONTAINED IN THE EIR INADEQUATE?

Petitioners argue the inadequacy of the air quality impacts discussion in the EIR because they contend that it contains no analysis "... of the health impacts that would result from
admittedly significant emissions of particulate matter (PM$_{10}$ and PM$_{2.5}$) due to dairy operations. Indeed, the document did not even estimate the quantity of fine particulate matter (PM$_{2.5}$) that would result from the huge amounts of ammonia emitted by livestock waste. Respondents plead a dearth of available information to allow them to quantify PM$_{2.5}$ emissions, and, as to the failure to discuss the potential health impacts of PM$_{10}$ and PM$_{2.5}$, assert that "because the project is to be located at least one mile from any sensitive receptors, however, the record contains no evidence that PM$_{10}$ generated by the project could result in a significant health impact."

Review of the pertinent portions of the record demonstrates that, while standards have not been adopted by state and federal agencies regarding of the emissions discussed in this case, there is no evidence to indicate that there is an inability to quantify the amount of those emissions. Further, with the exception of a statement in the Administrative Record (AR 2066) that: "...the SJVUAPCD has indicated that dairies located within one mile from a sensitive receptor could generate odors that may be significant," this Court has not been able to find any basis in the record for concluding that no health impacts are to be expected from the emissions under discussion if the nearest sensitive receptor (human habitation, schools, and the like) is located at least a mile away from the project. Finally, the Court would note the Administrative Record reflects (AR 2065) that there is at least one rural residence within .9 miles of the project.
Respondents argue they have done the best they can in conservatively treating issues involving the generation of PM$_{2.5}$ by declaring that those emissions would generate a significant impact. The fact that an impact is found to be significant and unavoidable, however, does not gainsay the fact that the EIR itself must detail to the extent possible the significance of the emission so that an informed public may comment upon that information.

V.

DID THE COUNTY VIOLATE CEQA BY FAILING TO ANALYZE AND ADOPT FEASIBLE MITIGATION MEASURES FOR AIR AND WATER QUALITY IMPACTS?

Petitioners allege that, while acknowledging the project will generate air pollution in the hundreds of tons of toxic gasses and particulates yearly, the County "... astonishingly found that there was no feasible mitigation for most of this air pollution. The Borbas themselves urged the adoption of a broad air pollution mitigation regime, albeit a vague one. The County ignored even the Borbas and forged blindly ahead in approving the project. The County's action must be remanded to address this critical emission ...".

(A)

Petitioners specifically contend the County neither assessed nor adopted a number of feasible ROG control measures. The EIR originally required the use of an anaerobic digester. This was the only ROG mitigation measure evaluated in the EIR. However, the Borbas opposed the requirement of an anaerobic digester and suggested that they instead commit to using "the best available
"economically feasible technology" in lieu thereof. But the Board rejected the anaerobic digester, and ultimately the mitigation measure adopted with regard to ROG was:

"The project shall provide for an aerobic treatment system or equivalent to stabilize the manure generated by the cattle prior to land application. The aerobic treatment system shall be designed to minimize the release of biogasses through conversion of gasses to electrical power or other methods."

Respondents argue that "under this mitigation measure, the Borbas must construct an aerobic treatment system or a system with equivalent results. The reference to 'conversion of gasses to electric power,' which would only be possible with an anaerobic system, makes clear that one way the Borbas may fulfill this mitigation measure is by constructing an anaerobic system. Therefore, petitioners' statement that the County required no mitigation for ROG is blatantly false."

The problem with the state of the record is that there is no adequate discussion within the EIR of available technology involving aerobic treatment. Even if ultimately found to be infeasible, evaluation of an aerobic system as a potential feasible mitigation should have been accomplished to determine whether it would substantially lessen the ROG impact before the mitigation measure was adopted in its final form. Furthermore, nothing in the EIR sets forth the standard to be used to determine that a substitute system would be equivalent to an aerobic treatment system.
Petitioners next attack the alleged failure of the EIR to assess and adopt feasible particulate matter mitigation measures. They allege that the sole mitigation measure proposed for particulate matter emissions during dairy operations was the application of a chemical stabilizer. Petitioners urge that the EIR should have considered offsets as a feasible mitigation measure for both particulate matter emissions and for ROG emissions.

Respondents reply that in addition to chemical stabilizer application, they also provided Mitigation Measure 4.2.3.3 which required the applicants to plant landscape trees along three sides of the dairy sites. Furthermore, there was a requirement for the regular removal and treatment of manure from the corrals to prevent it from becoming a PM$_{10}$ source.

There is ample evidence in the Administrative Record to justify the chemical treatment of particulate matter mitigation contained within the EIR. The suggestion by Petitioners that offsets be used to counter the effects of ROG emissions and particulate matter generation is effectively answered by Respondents' argument that to have a system of offsets there has to be an administering agency with the appropriate authority to supervise the program. Since the record demonstrates no such authority exists in that, for example, the SJVUAPCD does not regulate dairies as point sources, there is no basis in the record to suggest the feasibility of an offset system as a mitigation measure with regard to air quality control.
Petitioners next address the alleged failure to assess and adopt feasible mitigation measures for ammonia and hydrogen sulfide emissions. Petitioners argue that since ammonia and hydrogen sulfide will not be effectively regulated by the responsible air district and the EIR demonstrates their significance it must evaluate and/or require a mitigation measure for those emissions. Because the Court has already addressed issues concerning the adequacy or inadequacy of the assessment of the effects of the generation of air pollutants and the efficacy of the adoption of an aerobic or anaerobic treatment system, supra, there is no need for further discussion of this issue under this rubric.

Petitioners turn to a discussion of the alleged failure of the EIR to evaluate feasible mitigation measures for water quality impacts. They argue that the County failed to deal with the comments of the McAllister Ranch Irrigation District and the West Kern Water District regarding provision for the cost of remediation of ground water in the event it becomes polluted by the project operation. Respondents allege that the comments of the McAllister Irrigation Ranch District came late in the process and contend that the County did respond to the concern that the Bore bas be held responsible for potential effects on the ground water. However, the portion of the Administrative Record to which they cite (AR 8:4648-4649, 4653) do not deal with the issue presented. Since the recommended solution for the problem of mitigation in the event
groundwater was polluted by the dairies does not appear on the record before the Court to be facially infeasible, it must be addressed. (See Los Angeles Unified School District v. City of Los Angeles (1997) 56 Cal.App.4th, 1019, 1029.)

(P)

Petitioners raise two issues with regard to the question of potential seepage from the dairies' wastewater lagoons. First, they complain that the EIR includes no description or analysis of the soil underlying Dairy #2, and consequently there cannot be an informed evaluation of the water quality impact of that part of the project. Respondents contend that, since Dairy #2 is located adjacent to Dairy #1, the soil characteristics are expected to be nearly identical and therefore should not pose a problem. While this argument is not persuasive, Respondents make a second argument, which is that Mitigation Measure 4.3.3.2 contains performance standards for the hydraulic conductivity of the liner systems for both dairies. Given the state of the record, this Court cannot say that the decision of the Board to accept the mitigation measure and the planning in the EIR for the wastewater lagoon, insofar as Dairy site #2 was concerned, constituted an abuse of discretion, or was made without substantial evidence.

Petitioners' second argument concerning the lagoons involves the alleged failure of the EIR to evaluate "...the volume of seepage, the quantity of pollutants and the speed at which they would reach groundwater...." They argue that the result constitutes a failure to include relevant information to allow
informed decision making by the Board, and also appropriate public participation in the project. In this regard they rely on the case of Kings County Farm Bureau v. City of Hanford (1990) 221 Cal.App.3d 692, 712. They also cite the case of Cadiz Land Company v. Rail Cycle (2000) 83 Cal.App.4th 74. The latter citation is appropriately attacked by Respondents who point out that the Petitioners' attempt to argue that the Cadiz case was a case concerning a failure to calculate volume of discharge from a project, when it really dealt with a failure to calculate the volume of a diminishing aquifer to ascertain whether or not the aquifer would disappear before expected pollution from the project reached the level of the groundwater.

Respondents go on to justify their treatment of the issue of leakage and their failure to provide a calculation of that leakage by further distinguishing the project in the Cadiz matter and the current project, pointing out that in Cadiz the EIR concluded groundwater contamination was highly unlikely and therefore not a significant impact, but that the current EIR and project approval "...recognizes that potential contamination is a significant impact and mitigation measures have been incorporated."

Respondents again appear to be of the view that if an EIR concludes a project threatens to create a significant impact upon the environment there is no further information to be provided with regard to that impact. But that is not the state of the law. Here calculation of the volume of seepage from the lagoons was crucial to the public's and the Board's ability to fairly analyze the
sufficiency of the proposed mitigation measures: "A prejudicial abuse of discretion occurs if the failure to include relevant information precludes informed decision-making and informed public participation, thereby thwarting the statutory goals of the EIR process." (Concerned Citizens of South Central LA v. Los Angeles Unified School Dist. (1994) 24 Cal.App.4th 826, 838.)

Consequently, the argument of Petitioners regarding the inadequacy of the analysis of the effects of leakage from the wastewater lagoons, although flawed by their distortion of the Cadiz holding, accurately characterizes the problem to be dealt with herein.

(F)

Concluding their attack on the alleged failure of the EIR to adequately deal with water quality impacts, Petitioners assert that the EIR does not sufficiently analyze the impacts of non-nitrogen salt loading. Little attention was paid to this issue in the presentation of evidence by Petitioner Sierra Club. Respondents argue that the RWQCB allows salt loading of up to 3,000 lbs/acre/year, whereas the project in question will load an estimated 401 lbs/acre/year. Consequently, it appears there was substantial evidence before the Board to justify the Board's

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1 While Respondents contend the rate of seepage was reported in the EIR in centimeters per second, and that seepage from the lagoons can then be converted to volume of discharge by accomplishing "a simple conversion using information in the EIR," one purpose of the EIR is to make the public aware of significant environmental issues inherent in the development of a project. When one has to be familiar with mathematic formulas to understand significant information, the EIR does not accomplish one of its requisite goals.
approval of the project insofar as the issue of non-nitrogen salt loading was concerned.

CONCLUSION

Based upon the foregoing analysis, the parties to this action are entitled to relief as follows:

1. Individual Petitioners Maria Cruz Medina, Frances L. Aguilar, and Maria Martinez are dismissed from the action for want of standing.

2. The remaining Petitioners are entitled to a Writ of Mandate compelling Respondents/Real Parties to refrain from taking action in furtherance of the project until they comply with CEQA in the following regard:

   a. Performing a cumulative impact analysis which includes consideration of the effect of the 34 existing Kern County dairies, the three additional recently approved Kern County dairies, and the existing and approved (but not yet constructed) dairies in the remaining seven counties in the San Joaquin Valley Air Basin;

   b. Performing a meaningful analysis of feasible alternatives to the project in question, including the alternative of a reduction in the size of the project;

   c. Analyzing the health impacts that would result from the estimated emission of particulate matter due to dairy operations, and in the process estimating the quantity of fine particulate matter (PM$_{2.5}$) that would result from the operation of the project;

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d. Analyzing the efficacy and practicality of the utilization of an aerobic treatment system (the mitigation measure adopted by the Board) and including a verifiable standard to be used to determine the basis for finding that a system to be put in place of an aerobic treatment system is an equivalent system;
e. Analyzing solutions for the cost of mitigation in the event groundwater is polluted by the project;
f. Detailing in a fashion comprehensible to members of the public and the Board the volume of leakage anticipated from the lagoons.
July 19, 2001

Mr. Aaron Isherwood  
Sierra Club Environmental Law Program  
85 Second Street, Second Floor  
San Francisco, CA 94105-3441

Re: Review of Revised Draft Dairy Element of the Kings County General Plan

Dear Mr. Isherwood:

I have reviewed the Program Environmental Impact Report and Revised Draft Dairy Element of the Kings County General Plan (Revised Draft Element) dated May 7, 2001, and have the following comments:

Review of TechCon's February, 2001 Comments (attached):

1. Policy DE 3.2h - this policy should be revised to include a provision for impermeable membrane liners should a qualified Certified Hydrogeologist or Professional Engineer determine that natural conditions do not provide an adequate hydrogeological barrier to pollutant transport.

2. Revise Policy DE 4.1a, (B)(2)(c) to prohibit the discharge of process water through the soils lining the pits and lagoons to below $1 \times 10^{-7}$ cm/s, to protect groundwater supplies. Assuming 0.45 lbs/day/animal unit of nitrogen produced by lactating dairy cows (at 1.4 animal units each), freestall dairies, no solids removal prior to the waste reaching the lagoons, and a wastewater production of 144 lbs/day/cow, the less restrictive NRCS standard of $1 \times 10^{-3}$ cm/s would allow 230 lbs per day (43 tons per year) of nitrogen alone to infiltrate to groundwater, based on the projected maximum herd size in the Revised Draft Element. The more restrictive standard would reduce that to 2.3 lbs per day and...
0.43 tons per year, which would be negligible across the county. Salts associated with dairy waste may be even more damaging to groundwater quality, as described in section 4.3 of the Revised Draft Element. The impact of lagoon water nitrogen and salts would be over and above the impacts associated with existing agricultural practices.

3. Policy DE 5.1c: My concerns regarding specificity of air quality criteria have been partially met in the current Draft. However, the stated goal of 50 percent reduction in volatile solids within the treated manure and dairy process water is not protective enough. This goal should be raised to 60 percent reduction in volatile solids within the treated manure and dairy process water, a goal that can be met according to the sources cited in the Revised Draft Element as outlined further in this letter. In addition, standards for emitted gases are not included in this policy. If specific performance standards for emitted gases are included, then air quality is much more likely to be protected.

New Comments:

1. The Revised Draft Element states on page 4.2-3, “The San Joaquin Valley is currently in non-attainment for the Federal standards for ozone and particulate matter with an aerodynamic diameter less than or equal to ten microns (PM$_{10}$)”. Table 4.2-5b of the Revised Draft Element shows estimated PM$_{10}$ emissions from cattle movement in unpaved corrals. Under the most optimistic projection of future conditions, 203 tons per year more PM$_{10}$ will be emitted by cattle movement in unpaved, but stabilized corrals, than is currently emitted (under Policy DE 5.1c).

None of the policies cited as mitigating measures under the PM$_{10}$ impact discussions, Impact 4.2-3 on page 4.2-53 (new or expanded dairies) and Impact 4.2-11 on page 4.2-78 (Implementation of the Element), are noted to be sufficient to reduce PM$_{10}$ emissions to below a significant increase. The conclusion within the Revised Draft Element is that “the impact would constitute a significant and unavoidable adverse cumulative impact”. However, there is an available mitigation measure that is not included in the Revised Draft Element. In Dairy Waste Pollution Reduction, I have proposed the adoption of enclosed freestall dairies. “Enclosed freestall dairies have the additional advantage of eliminating dust generation from unpaved corrals due to wind-blown dust and cattle movement. This source of fine particulate matter (PM10)
is shown by Kings County data to contribute between 14 and 37 percent of all
the PM10 generated annually in Kings County (Kings County, 2001). Eliminating
dairy operations as a major source of PM10 would significantly
affect air quality in the San Joaquin Valley.” (Gay, 2001) In addition, dust
control stabilizer can and should be required for use in existing dairies as well
as expanded dairy facilities. By implementing these policies, PM10 emissions
might be held within SJVUAPCD limits.

2. In discussing available manure treatment technologies on pages 4.2-14 and
4.2-15, the authors of the Revised Draft Element state, “Treatment
effectiveness currently cannot be measured by quantifying the reduction rate
of the individual odorous gas compounds because of the lack of available
scientific methods to do so. Therefore, a conclusive determination of whether
residual air pollutants are emitted from treated manure is not possible until
sufficient information and data are available to quantify the concentration of
individual odorous gases (i.e. ammonia, hydrogen sulfide, ROG) in treated
manure. In addition, best available control measures or technologies have not
been developed by regulatory agencies (e.g., CARB, EPA) to address
reducing potential adverse air quality effects from livestock manure
emissions.”

There are definitely scientific methods available to quantify organic gases
originating from treated manure. In Standard Methods for the Examination
of Water and Wastewater, 20th Edition (APHA/AWWA/WEF, 1998), the
following methods are available to quantify gasses emitted from anaerobic
sludge (2720 C), and odor threshold (2150 B). Ambient air samples can be
obtained using a portable sampling pump to fill “Tedlar” gas sample bags. It
is also possible to obtain field measurements of ammonia and hydrogen sulfide
using pre-calibrated, substance-specific reagent chips accurate for
concentrations between 2 and 50 ppm for both substances, or detector tubes
are available accurate between 2 and 1000 ppm for ammonia and 0.2 and 4000
is not necessary to determine whether residual air pollutants are emitted from
treated manure, particularly odorous gases. To a person familiar with
wastewater treatment chemistry and experienced with dairies, it is relatively
easy to detect and distinguish trace amounts of ammonia, hydrogen sulfide,
and ROG. The odor threshold of ammonia is 50 ppm, which corresponds to
the OSHA limit for exposure (Agency for Toxic Substances and Disease Registry, Occupational Safety and Health Administration [OSHA]), and for hydrogen sulfide the odor threshold is 0.13 ppm, with an exposure limit of 20 ppm (OSHA).

Though regulatory agencies such as CARB and EPA do not have official best available control measures or technologies in place for controlling residual air pollutants from treated manure, there are common best management practices in place in dairies that are available for odor control of treated manure. Some proven odor control techniques include:

A) Waste nutrients only applied during periods of low wind speeds, such that aerosols and odors are minimized from drifting onto neighboring areas
B) Minimize spreading or agitation of manure or waste nutrients when the wind is blowing toward populated areas
C) Apply treated manure during periods of low humidity
D) Windbreaks planted to enhance a "chimney" effect so that odors rise and dissipate before reaching residential areas
E) Apply treated manure to fields at agronomic rates

3. The best information available on plug flow digester performance at a dairy is provided in a paper on the 360 to 400 cow Langerwerf Dairy, (Moser and Langerwerf, 2000) based on 16 years of digester operation. This dairy treatment system was the subject of a profile in Dairy Waste Pollution Reduction (Gay, 2001). From solids sales records, the amount of accumulated solids left in the digester, and conservative estimates of the solids removal from the cow yard (80%); retention of digested solids at the dairy(50%); and digested solids total solid content (13%); the estimated volatile solids solids reduction experienced at the Langerwerf Dairy over 16 years was 64%. With the benefit of a larger volume plug flow digester and more frequent cleaning (every 5 - 10 years instead of after 16 years), it is likely that a higher volatile solids reduction would result. Therefore, using 60% as a target for VS removal is realistic and more environmentally protective than the 50% advocated in the Revised Draft Element on page 4.2-24 and included in Policy DE 5.1c on page DE-35.
4. The authors of the Revised Draft Element thoroughly point out that not enough is known to require specific comprehensive treatment guidelines. On page 4.2-27, “The understanding of livestock operation-related air quality issues is limited, as evidenced from the current research projects being performed by USDA ARS.... In addition, current research is not specifically addressing all of the issues being faced in the southern San Joaquin Valley. In particular, emission of ROG and other ozone precursors is not currently being studied. Similarly, research directed at estimating or measuring PM$_{10}$ emissions from dairy corrals has not been identified by ARS as a research topic.” Since treatment requirements for wastewater and air quality are to protect water and air quality at the specific location of each dairy, as well as protect the overall Kings County environment, review of the treatment efficacy of a proposed dairy waste management system must be site specific. Kings County Planning is proposing to implement a site plan review (SPR) requirement: “Site Plan Review (SPR) application approval by the Zoning Administrator (ZA) is a ministerial action requiring the ZA to insure all regulations, policies, mitigation requirements, standards, etc., in the Zoning Ordinance, Dairy Element, and Dairy Element Program EIR are met in the design of the facility.” While this will implement an administrative level of review of proposed and expanding dairies, it does not allow for public review of the process unless the planning commission decides that the dairy is in violation of SPR provisions and requires a conditional use permit (CUP) process, during which the public is notified and given the opportunity to “report any violations of the regulations they may observe.” There is no specific mention of a public comment process for either the SPR or CUP processes.

5. On page 4.2-40, the description of Policy DE 5.1c concludes with, “The policy indicates that the requirement for implementation of advanced treatment technologies would be waived for proposed existing dairy expansion projects that do not include proposed construction of new dairy facilities and for which the expanded dairy herd would not exceed the calculated capacity and would not result in ROG emissions that would exceed the SJVUAPCD threshold limits set for a stationary source.” It is not clear why ROG is the only emission included in the potential limit to herd size expansion at existing dairies without implementation of advanced treatment technologies. As noted above, PM$_{10}$ can be controlled by requiring enclosed freestall housing of dairy cows, and methane, ammonia and hydrogen sulfide emissions can be reduced by using anaerobic digestion coupled with cogeneration and stack emission control.
Otherwise, the cost-effective approach for the dairy industry is to simply expand existing dairy herds to the maximum capacity of the available land and milk parlor facilities without regard to the cumulative impacts of increased herd size on existing waste treatment and disposal systems.

6. An additional advantage of anaerobic digestion over non-treatment or aerobic treatment is power generation, which I discussed in *Dairy Waste Pollution Reduction* (Gay, 2001). “In cold and/or temperate climates with relatively high density development and associated high land costs, a plug-flow anaerobic digester coupled with an enclosed freestall dairy appears to offer significant benefits in low operation costs, energy efficiency and cogeneration, and a relatively small land use requirement. Recent experience with such digesters indicates that their operation has low maintenance requirements with the added benefits of gas collection, excellent odor control, and marketable, easily handled digested solids suitable for use as a fertilizer (Moser, et al, 1998).” By generating power from anaerobic digestion of manure, there is not only an economic benefit to the dairy, there are also avoided air emissions and/or other environmental impacts associated with more conventional power generation. In addition, basic stack emission control systems can be added to cogeneration facilities to reduce emissions. Conversely, aerobic treatment is a net power user. Therefore, power generation from an off-site energy source and the associated environmental costs are required to achieve the marginally better volatile solids reductions associated with aerobic treatment of dairy waste. None of these advantages of anaerobic digestion were discussed in the *Revised Draft Element*.

7. Projected air emissions of PM$_{10}$, methane and ammonia are shown to be significant in the *Revised Draft Element*. Emissions of these gases should be classified as a limiting factor for new and expanded dairies in Kings County.

8. Impact 4.3-7 in the *Revised Draft Element* states: “Activities associated with dairy facilities and support cropland could result in an increase in the rate of salt and nitrogen loading, and the release of pathogens in the basin, degrading groundwater quality. This is a less-than-significant impact.” The *Revised Draft Element* then proceeds to discuss the potential impacts for 15 pages, before concluding that no mitigation measures are required. However, the proposed policies listed in the discussion of this impact in the *Revised Draft Element* are expressly designed to protect water quality, thus attempting to mitigate the
impacts of the preferred alternative. However, as stated in my second comment from February, 2001, simply requiring impermeable membrane liners instead of allowing the standard NRCS permeability will considerably reduce impacts to groundwater from impounded liquid manure wastewater. Specifically, salt loading from stored wastewater would be cut 99%.

While requiring a groundwater monitoring program in Policy DB6.1h, the Revised Draft Element does not designate specific standards to limit water quality degradation. For example, safeguards and waste treatment should be required if salinity is projected to increase significantly as a result of a proposed or existing project; for baseline salinity between 250 and 500 ppm, a projected or actual salinity increase of 10% or more would trigger a reduction in salt loading by curtailing irrigation, limiting herd size, or removing a percentage of salts in commercial or manure fertilizer. Similar restrictions would apply for baseline salinity over 500 ppm; a salinity increase of 50 ppm would be the trigger. Safeguards for limiting nitrate and pathogen contamination would follow a similar pattern as those for salinity.

In summary, the Revised Draft Element still does not include the key information noted above to control air and water emissions from dairies. By advocating an administrative approach that ignores public input until administrators decide that a given dairy project is not being handled in compliance with that approach, the public loses the opportunity to provide non-technical input to the development of specific dairy projects. Such input might include anecdotal information about odor, and local experience with a given dairy’s discharges and management practices that otherwise might not be available to a Zone Administrator’s staff or other regulatory personnel. Unless such information is actively sought as part of a written procedure, it will most likely not become available until environmental damage is already done as a result of expansion or construction of new dairy facilities.

Sincerely,

Alan E. Gay, P.E.
Project Manager
1. Revise policy DE 3.2h to include a provision that should the Hydrogeologic Sensitivity Assessment conclude that there are inadequate hydrogeologic barriers to pathogen or contaminant migration toward groundwater as defined in EPA's proposed Groundwater Rule (or current version) FEDERAL REGISTER: MAY 10, 2000 PART 2. 40 CFR PARTS 141 AND 142. NATIONAL PRIMARY DRINKING WATER REGULATIONS, then an impermeable membrane liner shall be installed in accordance with California Environmental Protection Agency standards for lining wastewater lagoons.

2. Revise Policy DE 4.1a, (B)(2)(e) to prohibit the discharge of process water through the soils lining the pits and lagoons to below 1 x \(10^{-7}\) cm/s, to protect groundwater supplies. Assuming 0.45 lbs/day/animal unit of nitrogen produced by lactating dairy cows (at 1.4 animal units each), freestall dairies, no solids removal prior to the waste reaching the lagoons, and a wastewater production of 144 lbs/day/cow, the less restrictive NRCS standard of 1 x \(10^{-5}\) cm/s would allow 230 lbs per day (43 tons per year) of nitrogen alone to infiltrate to groundwater, based on the projected maximum herd size in the Draft Element. The more restrictive standard would reduce that to 2.3 lbs per day and 0.43 tons per year, which would be negligible across the county. Salts associated with dairy waste may be even more damaging to groundwater quality, as described in section 4.3 of the Draft Element. The impact of lagoon water nitrogen and salts would be over and above the impacts associated with existing agricultural practices.

3. The text of section 4.2 of the Draft Element on page 4.2-54 states, "...Policy DE 3.1a specifically addresses ammonia emissions in the development of countywide policy (no such specificity was found – TechCon), Policy DE 5.1c requires the preparation of an MTMP (Manure Treatment Management Plan - TechCon) that would be implemented to reduce air pollution emissions from the manure, including ammonia." Policy DE 5.1c's criteria for developing an MTMP are vague, and lack specific limits or goals for concentrations of emitted gases or reference to any particular objective standard. With regard to specifying treatment the criteria state, "The appropriate treatment technology, or combination of technologies, shall be selected on the basis of expected manure volumes and site-specific management strategies. The selected treatment system shall be designed to minimize, to the extent economically feasible, the release of air emissions into the environment." (page DE-34 of the Draft Element) Policy DE 5.1c continues, "The MTMP shall include quality assurance/quality control protocol to monitor the implementation and effectiveness of the manure treatment system. The MTMP shall be revised as necessary, based on the results of the monitoring program, to ensure that selected treatment technology is being implemented in a manner that will reduce or control odor from dairy operations." While it is important to reduce and control odor from dairy operations, it is also important to control relatively odorless emissions, such as methane and \(\text{NO}_x\). Also, by nature odor control efforts are difficult to objectively quantify. The specific gases listed earlier in Policy DE 5.1c are quantifiable, but are not specifically addressed in evaluating the effectiveness of the proposed MTMPs. I suggest that Policy DE 5.1c be strengthened such that MTMPs must include a provision that dairies demonstrate compliance with current CARB (California Air Resources Board) standards and goals for concentrations of atmospheric gases to the extent possible using BPT (best practicable control technology currently available).
Calculations:
Evaluation of Treatment Technologies
Prepared for: Sierra Club
By: Alan Gay, P.E.
TechCon, Inc.
6-Feb-01
Dairy Cow Nitrogen to Groundwater, King's County Draft Dairy Element

244,715 Projected Increase in Dairy Cows
1.4 Animal Units/Cow
0.45 lbs N/day/AU, Lactating Dairy Cows, from Animal Waste Management Field Handbook, NRCS
154,170.5 lbs N/day Additional Nitrogen produced by new Dairy Cows
Assume that these cows are in freestall dairies with 100% of waste manure routed to anaerobic
Digestion lagoons, and that these lagoons are lined to the NRCS standard of 1x10^(-5) cm/s permeability.
Freestall Dairies:
Water use/cow: 150 gal/day
= 20.05079535 cu.ft/day/cow
Milk Production: 18000 lb/year/cow
49.31506849 lb/day/cow
5.91227608 gal/day/cow
Remainder is waste: 144.0877239 gal/day/cow
= 19.26048976 cu.ft/day/cow
Freestall Dairy N/day: 154,170.45 lbs N/day
Subtract N emitted as atmospheric (per Draft Plan estimate)
5840 tons/year ammonia (middle value from estimate in Table 4.2-5a)
4812.16 tons/year ammonia as N
1761 tons/year NOx
397.986 tons/year NOx as N
5210.146 tons/year atmospheric N
28548.74521 lbs N/day
125621.7048 lbs N/day remaining in liquid
Freestall Dairy liquid wastewater:
471330.752 cu.ft/day
294111839 lbs/day
Concentration of N: 0.000427122
= 427.1222309 mg/l
Average depth of anaerobic dairy lagoon:
15 feet
Total surface area of anaerobic dairy lagoons at freestall operations:
314222.0502 square feet
NRCS Permitted infiltration rate:
0.00001 cm/s
3.28084E-07 ft/sec.
0.028346457 ft/day
8907.081737 cubic feet/day
Infiltration of N from Freestall Dairies at NRCS permitted infiltration rate:
237.3953476 lb/day N
43.32465094 tons/year N
Dairy Waste Pollution Reduction

Introduction

This report examines the current status of dairy wastewater treatment, and advocates a "total systems" approach to dairy design that is practical and protective of air and water quality. A "total systems" approach means that the entire dairy is designed not only to efficiently increase milk production but also to optimize waste and nutrient management. Key components of the total system design include the type of housing used for the animals, the waste collection approach, waste treatment, and utilization of the treated waste as a nutrient source. The total systems approach is advocated based on what is currently working in the dairy industry to provide milk produced in an environmentally protective manner.

Throughout this report, the two predominant types of dairy management will be contrasted: corral-style\(^1\) dairies and freestall\(^2\) dairies. The animal housing, waste collection, waste treatment and waste utilization all follow from the selection of one type of dairy management or the other.

Though the transition from family-owned and operated agriculture to ever-more centralized production has been occurring for some time in all types of agriculture, it has been especially acute in the dairy industry in the past decade (U.S. EPA, 2001). According to statistics reported by the U.S. Census Bureau, the average dairy farm increased in size from 32.75 cows per farm to 77.82 cows per farm between 1978 and 1997 (U.S.D.A., 1997). Between 1992 and 1997, the number of dairy operations with

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1,000 or more dairy cows increased from 564 to 878 (U.S.D.A., 1992a, 1997), while the total number of dairies decreased from 155,389 to 116,874.

An increasing percentage of milk is produced in dairies classified as “Concentrated Animal Feed Operations,” or CAFOs. A CAFO has 1,000 or more animal units, or is specially designated with 300 to 700 animal units. An animal unit is the equivalent of a 1,000-lb animal. Dairies with more than 700 head of mature dairy cows, whether milked or dry, are classified as CAFOs by the U.S. Environmental Protection Agency (EPA) (EPA, 2000).

Along with the transition from family-operated dairies to CAFOs have been several costs. When dairy cows are kept in close proximity to one another, a greater concentration of potential pollutants is generated than was previously the case with small family-operated dairies. These potential pollutants include emitted gases, such as ammonia, hydrogen sulfide (rotten egg gas), nitrous oxides, methane, and other odoriferous reactive organic gases. Many of these gases are toxic as well as odoriferous. There is increasing evidence that methane and other carbon compounds released into the atmosphere at rates above pre-20th century levels contribute to global warming (Wilkie, 1999, EPA, 1993).

**Air Emissions From CAFO Dairies**

Recent environmental analyses of very large dairies show tremendous potential to emit a wide range of air pollutants. The Kings County Draft Dairy Element of the Kings County General Plan Draft Program Environmental Impact Report (EIR), lists ammonia,
hydrogen sulfide, reactive organic gases and methane as gases produced emitted from dairy lagoons (Kings County, 2000). Estimated loadings for these same air pollutants were listed in the EIR of a very large proposed dairy in Kern County, California (Kern County, 1999). Air emissions are also one of the primary concerns driving the EPA to advocate use of covered anaerobic digesters (Moser et al, 1998). The following table shows estimated air emissions from dairy sources (Kings County, 2000).

**Estimated Annual Dairy Air Emissions, Tons**

<table>
<thead>
<tr>
<th>Sources</th>
<th>Methane (CH₄)</th>
<th>Hydrogen Sulfide (H₂S)</th>
<th>Ammonia (NH₃)</th>
<th>Reactive Organic Gases</th>
<th>Particulate (PM10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fugitive dust from cattle movement in unpaved corrals</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>54</td>
</tr>
<tr>
<td>Manure decomposition</td>
<td>256</td>
<td>--</td>
<td>156</td>
<td>29</td>
<td>NA</td>
</tr>
<tr>
<td>Cattle Digestion</td>
<td>372</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>NA</td>
</tr>
<tr>
<td>Total</td>
<td>628</td>
<td>Insignificant</td>
<td>156</td>
<td>29</td>
<td>54</td>
</tr>
</tbody>
</table>

Air emissions from manure decomposition and cattle movement are influenced by the selection of either freestall or corrals to manage dairy cattle, which is discussed further later in this report.

Air emission odors are quantifiable using an odor threshold test as defined in *Standard Sierra Club* May, 2001 Dairy Waste Pollution Reduction
Methods for the Examination of Water and Wastewater. This test could be used to limit the emission of otherwise difficult-to-quantify reactive organic gases (APHA/AWWA/WEF, 1998).

Seepage to Groundwater from CAFO Dairies

Potential pollutants may reach surface or groundwater, including nitrogen compounds, potassium, phosphorus, other nutrients and salts, traces of dairy antibiotics and hormones, minerals and cleansing compounds, and other organic pollutants. High volume releases of dairy waste include high fecal coliform counts and high biochemical oxygen demands that drastically impair water quality. Even small volume releases of insufficiently treated dairy waste to surface water will, over time, increase nutrient loads to those surface water bodies. High nutrient loads in surface waters are well linked to algae blooms, low dissolved oxygen, toxic releases from algae die-off, fish kills and impaired recreational value (Welch, 1990).

Numerous studies have shown that dairy waste may severely impact groundwater. In 1992, a groundwater study was conducted at the Hornby Dairy lagoon near Sunnyside Washington. This study showed that in silty soils, chloride concentrations in all wells downgradient of the main lagoon increased after the second and third quarters of monitoring (between four and ten months after the main lagoon received wastewater), probably due to leakage from the lagoon (Erickson, 1992). Chloride, being highly soluble, is a useful marker for groundwater from different sources.

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A study conducted in Orange County, California of the Chino Basin groundwater reservoir showed conclusively that dairies in the basin were contributing most of the salt contaminating groundwater in the three areas of the Chino Basin (CRWQCB, 1990). The concentration of total dissolved solids (salts) in the groundwater of Chino Basin III (where most of the basin's dairies are located) increased from a range of 300 to 500 mg/L in 1950, to 709 mg/L in 1986. In the period from 1991 and 1995, Chino Basin III salt concentrations were 772 mg/L (Wildermuth Environmental, 1999). Compared to other salt load contributors, lands receiving dairy manure contribute significantly more salt per acre. Lands receiving dairy manure include most of the remaining agricultural lands in the basin. In 1997, the theoretical dairy manure disposal area in the Chino Basin was 20,950 acres. Based on the number of milking and non-milking dairy cows, the manure application rate was 23 tons per acre per year, compared to the recommended 3 tons per acre per year to limit salt reaching groundwater (Wildermuth Environmental, 1999; CRWQCB, 1990).

In a recent analysis of a proposed large-scale dairy, Norman, Oklahoma engineer Kathy J. Martin, P.E., calculated the impact to groundwater from seepage from the lagoon system of a large proposed dairy. Assuming that the lagoons held average dairy lagoon concentrations of ammonia and total organic (kjeihldahl) nitrogen, and seeped toward groundwater at the California regulatory limit of $1 \times 10^{-5}$ cm/sec, they would contribute 83 tons per year total nitrogen to groundwater (Martin, 2000).

In south-central Idaho, the Idaho Department of Agriculture has been investigating high nitrate concentrations in rural wells located in close proximity to large-scale dairies. To
date studies have shown conclusively that agricultural practices are negatively impacting groundwater quality, including elevated nitrates (ISDA, 2000). Large dairies comprise a great deal of the agricultural activity in the impacted areas.

A study comparing the effectiveness of different lagoon lining material in New Mexico showed that even dairies using synthetic liners but with corral-style arrangements for cows contributed to groundwater contamination. Using data collected over a six-year period from monitoring wells around seven lagoons at seven different dairies with 1,000 or more cows, the study showed that even with a synthetic membrane lagoon liner, some contaminants were found at levels significantly above water quality standards. Total kjeldahl nitrogen (TKN), a measure of the amount of organic nitrogen, was relatively constant in the groundwater regardless of herd size and liner material. However, the study showed that use of synthetic liners, even with corral-style herd management, tended to very significantly reduce nitrate and ammonia concentrations in monitored groundwater. The authors’ conclusions were that mean contaminant concentrations exceeded groundwater quality standards for nitrate, ammonia, chloride and total dissolved solids at all dairies. The authors also concluded that clay liners are the least effective and synthetic membrane liners are the most effective for reducing groundwater contamination (Arnold and Meister, 1999).

A dairy with 1,000 mature dairy cows produces approximately 2,100 pounds of biochemical oxygen demand (BOD) per day (USDA, 1992b). In contrast, a city of 10,000 people produces about 2,000 pounds of BOD per day (Linsley and Franzini, 1979). Also by comparison, in 1996 out of 16,024 publicly-owned treatment works in
operation, serving populations as small as 200 people, all but 176 either did not discharge or had secondary treatment or better (U.S. EPA, 1999).

Dairies are not required to limit discharges to groundwater in any state in the United States to the degree that municipal waste water discharges to groundwater are limited, yet dairy wastewater loads are demonstrably higher per CAFO facility than they are for municipalities with up to 10,000 people. In the state of Washington, with the fourth-largest number of CAFO dairies in the United States (U.S. Census Bureau, 2000), until recently there was no enforced standard for seepage rates from dairy waste lagoons. The current standard in Washington is now based on the Natural Resources Conservation Service (NRCS) recommendation of $1 \times 10^{-6}$ cm/sec. Municipal wastewater lagoons, by contrast, are required by the Washington State Department of Ecology to install synthetic liners (Ecology, 1998). As with air emissions, the style of dairy management greatly affects the potential for impacts to groundwater quality. This subject is discussed further in the following sections.

Dairy Animal Housing and Waste Collection

Many new CAFO dairies are constructed as freestall dairies, either open-air or enclosed. A main advantage of this dairy construction style is ease of herd management and waste management. This arrangement is advantageous to dairy production in allowing for efficient feeding, medication and herding to the milking parlor. A freestall system housed in a barn (enclosed freestall) has the additional advantage of separating...
precipitation and runoff from the waste volume to be treated. If a scrape system is employed to move manure to a treatment system, then little or no additional water is needed in the treatment process.

Some new dairies under construction have corrals or pens configured between alleys. Such dairies generally have either high liquid waste collection routed to unlined waste storage lagoons that are likely to deteriorate groundwater quality and air quality, or inadequate waste management that will likely impact groundwater and air to an even greater degree than unlined waste storage lagoons. Where corral-style dairies are constructed with lined or monitored waste storage lagoons, the additional construction may result in prohibitively high capital and maintenance costs.

The designs for housing and waste collection on a dairy are logically linked. Along with the movement toward ever larger dairy facilities, dairy cow barn design has evolved toward freestall dairies. To optimize space as well as assist in protecting the health of the animals, freestall dairies are constructed to provide access for each cow to both the feed stalls arranged facing a feed alley, and a walkway behind each stall. The walkway is used by the cows to go toward the milking parlor and by the dairy to manage the herd effectively, rotating dry cows out and newly lactating cows in.

The freestall arrangement is also conducive to waste collection. When a set of cows is in the milking parlor, it is relatively easy for that portion of the freestall area to be scraped or flushed of accumulated manure. Since cows are commonly milked two to three times per day, manure removal can be quite frequent, keeping the freestall clean and relatively odor free.

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Scrape waste collection is usually accomplished with small motorized dozers or other non-automatic means. Automatic scraper systems have been determined by some dairies to be too costly for the benefit provided. For very large dairies, with greater than 2,000 milk cows, it might be cost-effective to implement an automated mechanized scraper system to save on labor costs, although the construction of such a system that would be safe for workers and cows would be quite capital intensive.

Open-air freestall dairies tend to use flush systems for waste removal. These systems can be automatic; however, the additional water used for the flush must be treated along with the rest of the waste stream, which may make construction of the treatment system more expensive and possibly uneconomical for the dairy as a whole (U.S.D.A. 1992b).

**Dairy Waste Treatment Approaches**

There are currently several categories of treatment technologies applied to treat liquid and solid dairy waste at CAFOs. In the four states with the most dairies larger than 500 cows, most dairy waste solids are composted or treated anaerobically. Liquid dairy waste is generally treated in deep lagoons that are functionally anaerobic, though they are usually managed as a storage facility rather than as a treatment facility (EPA, 1997). These anaerobic systems are generally not constructed with controls or monitoring for air emission or groundwater seepage.

Dairy waste treatments in use include: aerobic liquid waste stabilization; facultative lagoons; anaerobic treatment with and without supplemental aerobic treatment; and well-
mixed, uncovered anaerobic liquid waste treatment systems (EPA, 2001). Anaerobic treatment systems include plug-flow and mixed systems, as well as essentially unmanaged functionally anaerobic deep lagoons. In addition, there are other technologies currently being evaluated for dairy waste treatment, but that have not been applied to operating dairies.

For systems with low solids concentrations, aerobic treatment alone has been attempted. Even for relatively low solids concentration, high power inputs or large areas are required to achieve adequate treatment for water quality and air emission control. For high solids dairy waste, aerobic treatment is impractical (Roos, 2001). For systems that are operated as freestall dairies, low-liquid anaerobic systems appear to be the most cost-effective and environmentally protective systems currently available.
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Notes: (a) Lined = synthetic membrane liner, HDPE or equivalent in performance  
(b) ROG = reactive organic gases  
(c) H₂S = hydrogen sulfide gas  
(d) NH₃ = ammonia

In cold and/or temperate climates with relatively high density development and associated high land costs, a plug-flow anaerobic digester coupled with an enclosed...
freestall dairy appears to offer significant benefits in low operation costs, energy efficiency and cogeneration, and a relatively small land use requirement. Recent experience with such digesters indicates that their operation has low maintenance requirements with the added benefits of gas collection, excellent odor control, and marketable, easily handled digested solids suitable for use as a fertilizer (Moser, et al, 1998). In dairies with the low-liquid type of waste solids handling, milking parlor wastewater is most effectively handled with either a recirculating treatment/flush system or stored in a well-mixed, anoxic, lined basin prior to being carefully land-applied to forage crops.

Milking parlors are operated with relatively dilute wastewater compared to pen area waste. Some milk parlor waste water is recycled, such as cooling water recycled as wash water, then wash water used to provide enough liquid for the plug flow digester to function. If not recycled or added to a plug-flow manure treatment system, parlor wastewater is best treated in a lined, well-mixed anaerobic lagoon or treatment tank.

Parlor wastewater anaerobic treatment lagoons are either covered or uncovered, depending upon proximity to residential areas, prevailing winds, and pollution control requirements. If the anaerobic lagoon is well-mixed, it is more likely to maintain the correct ratio between those bacteria that produce acid and the bacteria that convert the acid to methane. Otherwise, the result is poor digestion, excessive odors, and poor solids characteristics (Wilkie, 1999).

High volume, liquid lagoon-based dairy waste treatment systems are often thought to be cost-effective in certain arid portions of the rural west. In arid climates with annual
evaporation rates significantly higher than annual precipitation, a lagoon will evaporate a significant percentage of stored wastewater, making liquid collection and waste storage attractive. However, proper control of air emissions and groundwater quality are imperative and quite expensive with high-volume, liquid lagoon treatment. To protect groundwater, the lagoon should be synthetic-membrane lined and monitored. Air quality can be protected by keeping the lagoon well-mixed and/or covering it with a membrane cover. In many instances, we can predict that the added cost of proper environmental controls will negate cost advantages of this type of treatment. The discussion below describes some of the most recent work on aerated and anaerobic treatment systems.

**Aerobic Systems.** Conventional surface aerators, while relatively inexpensive to purchase, in general have the disadvantage of a relatively shallow influence on the dissolved oxygen concentration in wastewaters, with DO concentrations reducing in proportion to the cube of the depth below the aerator. Conventional surface aerators also tend to create misting and aerosols that discharge volatile organic compounds, which are often odoriferous as well as environmentally damaging. Conventional surface aeration requires a great deal of power to operate. Therefore, for a look at aeration technology, other aeration techniques were examined for this report. Other aeration techniques include high-output subsurface aeration and subsurface membrane aerators. These techniques tend to have a lower ratio of power required to average DO concentration than surface aerators, and result in more thoroughly aerated treatment volumes.

Subsurface aeration appears to be gaining users in the municipal wastewater treatment industry. However, very few animal residuals generators use aeration of any kind, due to

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the high cost of power for the aerators. Several food processing industry wastewater generators use subsurface jet aerators. Fine-bubble membrane diffusion is used in high-solids municipal wastewater treatment. If aeration were to be used, these two means of delivering oxygen to the subsurface are the most efficient that are currently available, particularly for relatively high solids such as in dairy waste lagoons (usually total solids are 1,000 mg/L or above). Even with fine-bubble membrane diffusers and jet aeration, there is a very large power requirement compared to mixed anaerobic digestion or plug-flow anaerobic digestion. The operating expense of aeration is not warranted since aeration is best suited to reducing wastewater biological activity, which is not necessary in animal residuals systems that rely on land application.

**Anaerobic Systems.** For anaerobic digestion to work most efficiently with biosolids such as dairy cow manure, the temperature of the digester is maintained in a narrow range just below 100°F. In some relatively warm climates, maintaining a temperature range just below 100°F is feasible with heat from the biological activity of the digester, particularly if the digester is well insulated (in the ground) with a protected surface area (such as a cover). In climates with wide temperature ranges, where the frost depth may reach several feet below ground during the winter and ambient temperatures may exceed 100°F in the summer, anaerobic digestion without supplemental heat may not be feasible. Experience with unheated and uncovered plug-flow anaerobic digestion systems indicates that the digestion process is quite slow in colder climates, resulting in significant solids buildup while still producing unacceptably high concentrations of ammonia and hydrogen sulfide.

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According to Water Supply and Pollution Control, Third Edition by Clark, Viessman and Hammer and published by Harper and Row in 1977, “Problems in operating anaerobic treatment systems result when an imbalance (sic) occurs in the population dynamics. For example, if a sudden excess of organic matter is fed to a digester, acid formers (bacteria) very rapidly process this food, developing excess organic acids. The methane formers (other bacteria), whose population had been limited by a previous lower organic acid (food) supply, are unable to metabolize the organic acids fast enough to prevent a drop in pH. When the pH drops, the methane bacteria are affected first, further reducing their capacity to break down the acids. Under severe or prolonged overloading, the contents of the digester “pickle” in excess acids, and all bacterial activity is inhibited. In addition to organic overloading, the digestion process can be upset by a sudden increase in temperature, a significant shift in the type of substrate (bacterial food material in the wastewater), or additions of toxic or inhibiting substances from industrial wastes.” (Clark, et al, 1977)

Inherent in the operation of a plug-flow anaerobic digester system is the cost of maintaining a constant temperature range for the anaerobic cell. In addition, gas and odor control require gas enclosure, recovery, storage, and fate (flaring or power generation). Since anaerobic digestion removes nitrogen from the system by off-gassing nitrogen in the form of ammonia, some of the potential nutrient value of nitrogen for field application is gone. However, this may be desirable in many operations where waste generation nitrogen exceeds the crop requirement of the on-site acreage. The concentrations of phosphorus and potassium are relatively unaffected by treatment in a plug-flow anaerobic digester.

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Specific Installations

Aerobic

A high-output subsurface aeration system was examined, but determined to be inappropriate for use on most dairies, since there are more economical treatments available for the waste load and waste characteristics of a 2,000-milk cow dairy. A significantly larger dairy might warrant installation of a high-output subsurface aeration system if cost factors indicated that it was the most efficient treatment system to use. No dairies were located that use high-output subsurface aeration. High-output subsurface aeration systems are in use by the food processing industry, which generally has wastewater with high chemical oxygen demand and high solids loading (Waterlink, 2000).

John Reed and Art Riddick of Reed Engineering in Virginia have designed numerous high-output aeration installations, including many for food processing wastewater treatment plants. Mr. Riddick states that the influent BOD load is about 1,000 mg/l and the influent organic nitrogen load is about 300 mg/l, both similar to dairy wastewater from diluted, open-air freestall dairies. Mr. Riddick also reported that odor is well controlled, and the aerators have been uniformly mechanically reliable and easy to maintain, since all moving parts are located in a dry environment outside of the treatment basin (Riddick, 2000).

Aerobic Systems in the San Joaquin Valley are described in the Kings County Draft Dairy Element of the Kings County General Plan. One dairy facility in Kings County
and one dairy facility in Kern County operate aerobic treatment systems. The aerobic treatment system in Kings County was developed as a six-month pilot study conducted at the Longfellow Dairy in Hanford; the study was conducted by Rain for Rent, Mazzei Injector Corporation, University of California at Davis, and the University of California Cooperative Extension Service. The treatment system was designed to handle approximately 5,000 gallons per day of flushed manure. The system consisted of a solids separator, two treatment tanks equipped with aerators (two-stage treatment), and an effluent storage basin. Flushed manure was effectively treated to eliminate the potential generation of ammonia gas by implementing a two-stage process, where the organic loading was reduced in the first stage and the conversion of nitrogen to nitrate was accomplished by nitrification in the second stage. However, although treatment would reduce the total suspended solids of the manure, periodic cleaning of the system would be needed to remove eventual solids accumulation in the tanks (Meyer, et al, 2000, Kings County, 2000).

In the first months of 2001, the cost of electric power has increased significantly in California and appears likely to increase across the nation. Based on a calculation of power consumption for the system, at 10 cents per kilowatt-hour, the electricity cost for aerobic treatment would add 12 cents to the cost of each gallon of milk.

**Anaerobic**

**Covered Anaerobic Lagoon** - Dr. Doug Williams of Cal Poly State University in San Luis Obispo, California reports that odor difficulties at the university’s dairy were primarily associated with the unmixed storage lagoon that accepts stormwater and the

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effluent from the covered anaerobic wastewater treatment cell. That lagoon is scheduled to have a mixing and/or aeration system installed in the near future. The anaerobic cell is a 4-million gallon, 250-foot square, 15-foot deep (average depth) basin that is completely covered by an air-tight flexible membrane. Ammonia, methane and hydrogen sulfide are collected inside the membrane and routed to a micro-turbine for power generation used to operate the dairy's milking parlor. Dr. Williams acknowledged that the treatment system was large for the 200 cows currently at the dairy. He said that the dairy system capacity was designed for 500 cows (Personal communication, Williams, 2000).

The influent concentration of the Cal Poly dairy milking parlor wastewater is 4,000 to 5,000 mg/l Chemical Oxygen Demand (COD), and the effluent COD concentration is about 1,000 mg/l. The operating temperature of the cell is between 60° and 74°F, which is considerably below the conventional recommended range. Nevertheless, Dr. Williams reported that the anaerobic bacteria at the Cal Poly facility have adapted to the lower temperature and are keeping up with the influent loading quite well. Since Cal Poly’s facility routes stormwater to the storage lagoon below the anaerobic treatment basin, the liquid level in the anaerobic basin is kept at a constant level. Constant temperature, controlled anaerobic conditions, and a constant water level are factors that greatly facilitate maintaining a viable anaerobic bacteria colony. Liquid effluent from the storage lagoon is land-applied for nutrient supplement (Williams, 2000).

**Plug-Flow Uncovered Anaerobic Lagoon -** Gail Clowers of WSU's Puyallup facility reported that from 1985 until 1997, his facility operated an anaerobic lagoon. During that period lagoons that were not receiving effective treatment filled with solids, even with the
temperate climate of Puyallup, Washington. Mr. Clowers reported that he had to spend over $20,000 to dredge the anaerobic lagoons at the dairy to make enough volume available for the required liquid storage for the facility (Clowers, 2000).

The Puyallup facility’s anaerobic lagoon was not insulated, nor was there any attempt to recover emitted gases. The sole purpose of the lagoon was to enhance manure handling, which was not effective. It is likely that the lagoon became too acidic, which resulted in odor complaints and poor flow characteristics.

**Well-Mixed Anaerobic Lagoons.** There are several dairies now utilizing well-mixed anaerobic wastewater lagoons. Researchers contacted at WSU have indicated that they are planning to implement extensive analysis, in conjunction with the University of Idaho, of the ammonia gas production of an existing and also possibly a newly-constructed dairy lagoon system using low-speed surface mixers. As part of that research effort, data will be collected on the lagoon’s hydraulics, oxygen, BOD, nitrogen compounds and solids concentration both with and without using low-speed surface mixers (Yonge, 2000).

**Plug-Flow Covered/Insulated Anaerobic Digester, Minnesota** - The Haubenschild Dairy located near Princeton, Minnesota, is a 450-cow dairy that has a covered freestall barn system. The stalls are cleaned with manure scrapers that deposit the manure in a viscous slurry that is routed to a mixer and then to a heated, insulated, covered anaerobic plug-flow digester. Processed manure from the digester is marketed as a soil amendment. Liquid effluent from the milking parlor washwater is routed to the mixer to provide sufficient dilution for the manure slurry (Nelson & Lamb, 2000). Since the waste stream...
is entirely contained within impermeable barriers such as the concrete freestall floors and the concrete digester, this dairy does not adversely impact groundwater quality.

**Plug-Flow Covered/Insulated Anaerobic Digester, California** – The Langerwerf Dairy, located near Durham, California, has been operating a plug-flow anaerobic digester since 1981. In 1998, the digester was refurbished. The key to the successful operation of this digester system is the original digester design and construction, as well as the dairy’s attention to maintenance. By the time of refurbishment in 1998, the mechanical systems, predictably, were in the greatest need of replacement. In addition, the digester cover had developed pin-hole leaks, primarily from ultra-violet light degradation of the Hypalon membrane material. One of the findings during clean-out of the digester was the lack of struvite, magnesium ammonium phosphate, a common compound formed during treatment of organic wastes (Moser & Langerwerf, 2000). Struvite buildup physically inhibits the flow in waste treatment systems. The lack of struvite is testimony to the long-term efficient operation of the plug-flow digester at the Langerwerf Dairy. As with the Haubenschild Dairy, the Langerwerf Dairy’s use of impermeable surfaces for manure management is protective of groundwater quality.

**Mixed, Covered Anaerobic Digester** - In the Environmental Impact Report for the Borba Dairy, a 28,000 head facility proposed for location near Bakersfield, California, Mr. John D. Fleming, PhD, of Mead & Hunt West, Inc. suggests that of anaerobic treatment system technologies, a lagoon-based covered anaerobic system is most appropriate for a dairy, based on land availability and relatively low capital cost compared to the required investment for a fixed growth or combination anaerobic
digestion system. Mr. Fleming posits that maintaining a temperature in the range of 85 to 95°F would work, as defined in the *Standard Handbook of Environmental Engineering* by Robert A. Corbett, published by McGraw Hill. Among the features for such a system would be a sealed cover designed to meet seismic 4+ requirements, with methane filtration, moisture separation, and cleaned gas storage. For the proposed Borba Dairy, Mr. Fleming stated that such a system would cost about $8 million, including engineering and installation. This cost would include about 32 days of storage out of the required 120 days, so an extra 88 days of storage capacity and solids removal capabilities would also be required (Kern County Planning, 1999).

A spreadsheet model of the manure cycle for the proposed Borba Dairy was generated. This model indicated that the least cost alternative with sufficient environmental controls on air and water emissions for the proposed 28,000 milk cow facility would be a series of covered plug-flow anaerobic digesters receiving waste from scraped freestalls. Liquid wastes from the milking parlor would be treated most cost-effectively with recycling of cooling water, followed by discharge to a synthetically-lined, mixed anaerobic lagoon for wastewater generated in excess of the makeup water needed for the plug flow digesters.

**Glossary**

1. A corral-style dairy houses milk cows in large open pens, with access alleys surrounding the pens.

2. A freestall dairy houses milk cows in stalls arranged on either side of an access alley that the dairy worker uses to provide feed to the animals. Behind the stalls, which are open at the back, are runways that allow the cows to move freely between stalls.
3. An anaerobic process is one that takes place in the absence of atmospheric air, particularly oxygen. Anaerobic organisms (mostly bacteria) are the agents of biologic anaerobic processes.

4. A facultative organism can grow and multiply in the presence or absence of oxygen.

5. Plug-flow anaerobic digester is a fully enclosed treatment container through which waste moves as a plug, unmixed within the container. Waste treatment depends on providing the optimum environment for anaerobic bacteria already present in the waste. In the course of the waste's transit through the container, the bacteria within it convert some of the organic material to acid, which is then converted by other anaerobic bacteria to methane and other biologically-derived gases.

6. Cogeneration is power generation from a facility that has a primary purpose other than power generation.

7. Well-mixed, with regard to waste treatment, means that the material within the treatment container is assumed to be mixed enough to have the same composition throughout the container.

8. Anoxic means, literally, "without oxygen". Anoxic reactors utterly lack dissolved oxygen and use the oxygen in nitrate molecules to oxidize waste. This differs from the anaerobic reactor, where nitrogenous wastes are converted from ammonia to nitrate molecules (Biotech Life Science Dictionary Online, 2001).

9. High-output subsurface aeration systems have high volume blowers pushing air through ducts and discharging the air through nozzles. The nozzles are placed at or near the bottom of the waste treatment container, which is generally 12 to 20 feet deep.

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Virginia U.S.A.

ALAN E. GAY, P.E.
ASSOCIATE
CIVIL/ENVIRONMENTAL ENGINEER

Mr. Gay is a civil and environmental engineer with considerable experience investigating the environmental impacts of concentrated animal feed operations (CAFOs). He has developed water and wastewater treatment systems, has considerable environmental permitting experience, and has performed other in-depth engineering planning studies and systems analysis. His experience also includes a solid background developing and designing industrial sites, airport facilities, suburban developments, and environmental remediation.

Mr. Gay is currently evaluating the treatment and discharge of dairy wastes at several dairies regarding the requirements of the Clean Water Act and the general Washington state NPDES permit for dairies. He recently completed authoring an NPDES permit for an oil drilling facility in the Beaufort Sea and an NPDES permit for Chehalis Power Company for a new generating facility, and managed an investigative study and design with the State Department of Social and Health Services (DSHS) for wastewater facility planning with the City of Medial Lake.

Relevant projects performed by Mr. Gay include:

Agricultural Wastewater

1. *DeVries Dairy - Moxee Waste Systems Analysis - Yakima Valley, WA*: Mr. Gay is the nutrient management review engineer under contract to Washington FARM through Mr. Pete Optekar. Mr. Gay's tasks include analyzing and evaluating wastewater treatment, storage, and discharge at this planned 2,000 cow dairy in central Washington. Aspects of this project included evaluating the dairy's Nutrient Management Plan, the proposed treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, and biosolids application practices.

2. *Grandview Dairy Waste Systems Analysis - Gooding County, ID*: Mr. Gay is the lead engineer under contract to Bymann, Allison Hunter and Jones, P.S. His tasks included analyzing and evaluating wastewater treatment, storage, and discharge at this 1,300 cow dairy in central Idaho. Aspects of this project included evaluating the dairy's Nutrient Management Plan, the actual treatment received in pretreatment and
biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices. Additional services include groundwater transport of pollutants to nearby springs and wells in conjunction with a hydrogeologist, and the health and environmental impacts of that transport.

S&S Dairy Waste Systems Analysis - Yakima Valley, WA: Mr. Gay was the lead engineer under contract to Western Environmental Law Center. His tasks included analyzing and evaluating wastewater treatment, storage, and discharge at this 1,600 cow dairy in central Washington. Aspects of this project included evaluating the dairy's Waste Management Plan, the actual treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices.

George DeRuyter Dairy Waste Systems Analysis - Yakima Valley, WA: Mr. Gay was the lead engineer under contract to Western Environmental Law Center. His tasks include analyzing and evaluating wastewater treatment, storage, and discharge at this 3,500 cow dairy in central Washington. Aspects of this project included evaluating the dairy's Waste Management Plan, the actual treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices. Additional services included analyzing off-site runoff potential at sites owned by the dairy, and irrigation practices.

Henry Bosma Dairies Waste Systems Analysis - Yakima Valley, WA: Mr. Gay is the lead engineer under contract to Western Environmental Law Center. His tasks included analyzing and evaluating wastewater treatment, storage, and discharge at three CAFO facilities with a combined total of over 5,000 head, including two dairies with over 1,500 head of milk cows each in central Washington. Aspects of this project include evaluating the combined Dairy Waste Management Plan, the actual treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices. Additional services include analyzing potential Clean Water Act 404 Permit violations at several Henry Bosma-owned facilities that impound natural drainage ways.

DeRuyter Brothers Dairy Waste Systems Analysis - Yakima Valley, WA: Mr. Gay was the lead engineer under contract to Western Environmental Law Center. His tasks included analyzing and evaluating wastewater treatment, storage, and discharge at this 4,000 cow dairy in central Washington. Aspects of this project included evaluating the dairy's Waste Management Plan, the actual treatment received in pretreatment and biosolids (liquid and solid manure)
processes, lagoon design, lagoon integrity, and biosolids application practices. Additional services included analyzing off-site runoff and run-on potential at several sites owned by the dairy, irrigation practices and designing a wastewater monitoring system in settlement of the case.

- Sunnyveld Dairy Waste Systems Analysis - Yakima Valley, WA: Mr. Gay was the lead engineer under contract to Western Environmental Law Center. His tasks included analyzing and evaluating wastewater treatment, storage, and discharge at this 1,200 cow dairy in central Washington. Aspects of this project included evaluating treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices. Additional services included analyzing irrigation practices and designing a runoff monitoring system in settlement of the case.

- J&J Bosma Dairy Waste Systems Analysis - Yakima Valley, WA: Mr. Gay is the lead engineer under contract to Western Environmental Law Center. His tasks have included analyzing and evaluating wastewater treatment, storage, and discharge at this 1,500 cow dairy in central Washington. Aspects of this project include evaluating treatment received in pretreatment and biosolids (liquid and solid manure) processes, lagoon design, lagoon integrity, and biosolids application practices.

- Moses Lake Livestock Auction Wastewater Treatment Design/State Waste Discharge Permit & Design Report - Moses Lake, WA: Mr. Gay was the lead engineer designing and writing the state wastewater discharge permit application for the evaporative/land application treatment of truck wash waste water at this Livestock Auction facility located east of Moses Lake in central Washington. The ½ acre of lagoon storage was re-engineered with low-cost pretreatment and a combination of impermeable membrane and clay liners to protect surface and groundwater quality. Mr. Gay produced an Ecology-administered state waste discharge permit application and design report.

### Municipal Wastewater

- Combined Sewer Overflow Basin Planning - Consoer Townsend Envtrodyne/City of Spokane, WA: Mr. Gay helped CTE utilize information from the Combined Sewer Overflow Reduction Plan in planning combined sewer basin studies for the City of Spokane. Mr. Gay saved CTE many hours of analysis by tapping his familiarity with hydraulic and hydrologic modeling on the project, as well as the objectives of the original project.
Eastern State Hospital and Lakeland Village Wastewater Facility Planning Coordination: Mr. Gay managed this project to the design stage, including studies and analyses on pump station design and value engineering of City of Medical Lake plans necessary to assist the State Department of Social and Health Services (DSHS) during the joint facility planning process with the City of Medical Lake. Mr. Gay reviewed and interpreted the NPDES permits for DSHS, and assisted plant operators in meeting permit requirements.

Wastewater Facility Plan Study - City of Spokane, WA: Mr. Gay was Collection System Project lead in analyzing over 800 miles of sewer system, including 22 lift stations and 11 siphons for deficiencies in present and future scenarios. He reviewed and prepared draft of revised NPDES permit for the City's Spokane Advanced Wastewater Treatment Plant, with particular attention to phosphorus and ammonia limits. Mr. Gay also integrated the findings of the CSO Plan into the facility plan capital improvement program.

Combined Sewer Overflow Reduction Plan and Study - City of Spokane, WA: Mr. Gay was the project manager on this Ecology-approved study to prepare a CSO reduction plan consistent with EPA and Ecology CSO and NPDES standards. The project defined over $40 million in improvements and studies necessary to reduce CSO from current levels in the City's system by approximately 90%. Mr. Gay personally oversaw components of the study including collection system inventory and monitoring; BMP, treatment, and storage option alternatives for CSO reduction; authorship of the plan; hydrologic and hydraulic modeling; and report production.

Wastewater Source Study - Medical Lake, WA: Project Engineer and lead investigator for a short-term flow monitoring and sampling study to determine the source of high BOD and TSS discharges that violated the NPDES permit at the wastewater treatment plant at the Eastern Washington State Hospital.

Industrial Wastewater

Northstar Development NPDES Permit & Fact Sheet - British Petroleum, Seal Island, AK: Mr. Gay was the lead author to produce an EPA-administered NPDES permit and fact sheet to impose stringent permit limits on an oil drilling facility in the Beaufort Sea off the north coast of Alaska. The Northstar oil drilling facility will discharge various waste waters, including sanitary and desalination plant effluent. During the process of permit preparation, due to concerns raised by Mr. Gay and others, process water filter backwash was greatly reduced to limit thermal as well as potentially toxic effluents.
Chehalis Power Generating NPDES Permit & Fact Sheet - Chehalis Power, Inc., Chehalis, WA: Mr. Gay was the lead author and task manager to produce an EPA, Washington Department of Ecology (Ecology) and Energy Facility Site Evaluation Council NPDES Permit and fact sheet to permit a natural-gas-fired electrical generating plant. The plant is planned to use reclaimed municipal wastewater as cooling water, provide additional treatment, and discharge a small fraction of the ammonia, BOD, and metals loads of the municipal plant to the Chehalis River. The additional treatment concept and pre-engineering necessary for the permit were engineered by and performed under Mr. Gay’s direction. Mr. Gay also was the author of the adopted interim limits for the facility.

Hanford 200 Area Sewer Concept Design - Richland, WA: Project Manager for conceptual design of a major industrial wastewater collection and treatment system for the Department of Energy’s Hanford Site. The two collection systems included four lift stations and over 100,000 feet of pressure and gravity sewer pipe. Mr. Gay coordinated with Ecology in negotiating alternatives to an NPDES permit for the proposed systems, including the final concept of evaporative lagoon systems placed downwind of any occupied areas. The project was later canceled due to staff reductions at Hanford.

Industrial Wastewater Collection and Treatment - For Welch’s, Mr. Gay took over the lead of a project for industrial pretreatment and collection system modification at Welch’s Kennewick, Washington plant.

Stormwater

Bonaccelli Industrial Park, Spokane Valley - For a private developer, Mr. Gay is currently completing a stormwater system design integrating on-site and roadway stormwater under an agreement Mr. Gay brokered between Spokane County and the developer. The system will utilize conventional biofiltration swales for stormwater disposal for the 21 acre site.

Stormwater System Evaluation, Moran Prairie - For the Moran Prairie Neighborhood Council, Mr. Gay rapidly and accurately evaluated the stormwater design prepared by for a private developer by other engineers to assess the potential groundwater impacts of stormwater infiltration as proposed, and to make a preliminary evaluation of evaporative disposal.

Stormwater System Evaluation, Five Mile Prairie - For the Five Mile Prairie Neighborhood Council, Mr. Gay evaluated two stormwater designs prepared for private developers by other engineering firms,
assessing surface and groundwater impacts of the proposed systems. A win-win approach to the recommendations allowed the neighborhood council to reach a compromise with the developers.

Kaiser Aluminum and Chemical Company Heat Treatment Center - For a private developer under contract to Kaiser, Mr. Gay designed a simple, low-cost stormwater disposal system for a planned industrial complex in the Spokane Valley. Criteria included prevention of winter freeze overflows, minimization of piping, and accommodating future expansion on the 20 acre site.

Washington Water Power Central Operations Facility - For WWP, Mr. Gay lead the pre-design team in conceptualizing a system of cascading stormwater storage basins and a pumped disposal for the existing central operations facility, to bring it into compliance with City of Spokane stormwater handling requirements. Criteria included prevention of winter freeze overflows, minimization of piping, and accommodating future expansion on the 30 acre site. During the design and construction phase of the project, Mr. Gay performed technical review as the department manager.

Industrial and Commercial Stormwater Disposal systems - For numerous industrial and commercial clients, Mr. Gay has designed and overseen the construction of stormwater disposal systems ranging from biofiltration swales to complex retention and release systems for poorly draining soils.

Stormwater Pollution Prevention Plans (SWPPP). Mr. Gay has been the lead engineer on several SWPPPs, including most recently one for the Coville Indian Precision Pine Co. He has also been the project lead on numerous Spill Prevention, Control, and Countermeasure (SPCC) plans, prepared in accordance with 40 CFR Part 112.
Workshop on Atmospheric Nitrogen Compounds II:
Emissions, Transport, Transformation, Deposition and Assessment

ABSTRACTS BOOK

June 7-9, 199X
The Friday Center
Chapel Hill, NC
An International Workshop Sponsored By:

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N.C. Department of Health and Human Services, Office of the State Health Director, NC DHHS
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## International Perspective

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Emissions of atmospheric nitrogen compounds from farm animals in Canada, N.K. Patni and E. Pidgeon

The deposition of ammonia to semi-natural vegetation, field measurements, model simulation and new measurement approaches, David Fowler, C. Flechard, M. A. Sutton, R. L. Storeton-West, and K. J. Hargreaves

Instrument development and its application in studies of ammonia research and monitoring, Jan Willem Erisman, R. Otjes, A. Hensen, P. van den Bulk, and S. Slanina

Modelling the emission and deposition of ammonia on various spatial and time scales, Willem A. H. Asman, Johnny M. Andersen, Nicholas J. Hutchings

## SESSION I

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Ammonia emissions from swine waste operations in North Carolina, Viney P. Aneja, B. Bunton, J.P. Chauhan, B.P. Malik, J. Walker, Y. Li, George C. Murray, Jr

Field measurement of greenhouse gas emission rates and development of emission factors for wastewater treatment, Jeffrey LaCosse, Susan Thorneloe

Ammonia emissions from field applications of poultry manure, J.J. Meisinger, C.J. Schomburg, P.M. Zara, and R.B. Thompson

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Measuring chemical emissions using environmental CAT scanning, Lori A. Todd, Malika Ramanathan, and Kathleen Moitus.


Atmospheric ammonia and ammonium concentrations and estimated flux over the Tampa Bay area, Pai-Yei Whung, and Xu Li.

Ammonia-nitrogen emissions in North Carolina—Comparison among estimates with different emission factors, William Cure, Robert Wooten, and James Southerland.


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A neural network model to estimate ammonia in the atmosphere, Viney P. Aneja, Bok Haeng Baek, and Ronald B. McCulloch.

Multi-pollutant concentration mapping around a concentrated swine production facility using open-path FTIR spectroscopy, D. Bruce Harris, Edgar L. Thompson, Jr., David A. Kirchgessner, Jeffrey W. Childers, Matthew J. Clayton and David F. Natschke.

Trends in ammonium concentration in precipitation and local ammonia emissions at a Coastal Plain site in North Carolina, USA, Dena Nelson, John Walker, and Viney P. Aneja.


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Source-receptor modeling of wet ammonium deposition in North Carolina, USA, John Walker.

Estimation of atmospheric deposition of ammonium and nitrate in North Carolina and coastal river basins, Ellis Cowling, Cari Furiness, Luther Smith and Mark Henderson.
Atmospheric deposition estimates of nitrogen to the Atlantic and Gulf Coasts of the United States, Laurie Bowman, Christy Stoll, Lewis Linker, Julie Thomas, and Michael W. Palace.

Stable nitrogen isotopic tracers of sources of nitrogen in wet deposition on the North Carolina Coastal Plain, William J. Showers, Jon Karr, and Gayle Plaia.

Seasonal variations of nitric oxide fluxes from diverse physiographic agricultural soils in North Carolina, Paul A. Roelle, Viney P. Aneja, Bruce Gay, Tom Pierce and Chris Geron.


Nitric oxide flux from soil amended with municipal waste water, Desiree Rammon and J. Jeffrey Pierce.

Nitrous oxide emission from a spray field fertilized with liquid swine effluent, S.C. Whalen, E.N. Fischer and D.J. Brown.

Controls on denitrification rates in soils fertilized with liquid swine effluent, E.N. Fischer and S.C. Whalen.

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**Session IV**

Comprehensive model to study atmospheric nitrogen compounds, Rohit Mathur and Robin L. Dennis.

Nitrogen deposition airsheds for the Pamlico Sound watersheds: Development of oxidized nitrogen and preliminary estimate for reduced nitrogen, Robin L. Dennis, and Rohit Mathur.


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**Session V**

Atmospheric nitrogen deposition to the Neuse River Basin: Annual budget and spatiotemporal variability, D.R. Whitall, B.L. Peteris, and H.W. Paerl.

The role of atmospheric N deposition in coastal eutrophication: Current issues and perspectives, Hans W. Paerl, Monica B. Harrington and Tami L. Richardson.
An observation-based Gaussian dispersion model for determining ammonia emissions from a commercial hog farm, Ronald B. McCulloch.

Developing multi-media couplings to link ambient meteorological information with the deposition surface environment, Devdutta S. Niyogi, Kiran Alapaty, and Sethu Raman.


An integrated dynamic, physio-chemical approach to assessing the transport and deposition of chemical species in eastern North Carolina, Devdutta S. Niyogi, Kiran Alapaty, Tom Hopkins, and Sethu Raman.

Session VI

Controlling atmospheric emissions from animal waste treatment: Challenges and opportunities, Joseph Rudek.

Assessing the flux and bioavailability of atmospheric organic nitrogen to North Carolina Coastal Ecosystems, Benjamin L. Peierls, and W. Hans Paerl.

Groundwater contamination of private drinking well water by nitrates in homes adjacent to intensive livestock operations (ILO), Kenneth Rudo.

Posters

Coupled transport and chemical reaction model for ammonia emission at waste treatment lagoon-atmospheric interface, B. P. Malik, V. P. Aneja and J. H. Overton.

Environmental influences on nitrification in spray fields fertilized with liquid swine effluent, D.J. Brown and S.C. Whalen.

Comparison of emissions of nitrogen and sulfur oxides to deposition of nitrate and sulfate by state in 1990, C. Furiness, L. Smith, L. Ran, and E. Cowling.

Transport and fate of nitrogen oxide in the clay fraction of natural and engineered soil systems, L. Aiello and J. J. Peirce.

Evaluation of available control measures, potential emission reductions, and costs of control for anthropogenic emissions of nitrous oxide, W. Battye, A. S. Werner, and G. Hallberg.
Fractional portion of crop nutrient requirements provided by precipitation in North Carolina: Tobacco and loblolly pine, C. Furiness, L. Smith, L. Ran, and E. Cowling

Assessing the fate and transport of Atmospheric Nitrogen and VOCs in North Carolina: Potentials of the NC ECO Net, S. Raman, and D. S. Niyogi

Nitrogen is an essential element governing the development of living organisms, and in its various chemical forms, plays a major role in a great number of environmental issues. This workshop is scheduled as a follow up to a similar workshop held in March 1997. It is planned to be an open forum at which investigators and researchers evaluating atmospheric nitrogen emissions and fate will freely share current knowledge and ideas with other North Carolina, national and international researchers.

Workshop Chairman

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• Prof. K. Reckhow, Director, WRRI (ww2.ncsu.edu/nsfr/CIL/WRRI)

• Ms. Susan Wierman, Executive Director, Mid Atlantic Regional Air Management Association (marama.org)

• Dr. John D. Bachmann, Associate Director, USEPA (www.epa.gov)
Scientific Advisory Committee

- Prof. Viney P. Aneja, NCSU
- Prof. Ray Fornes, Associate Dean, NCSU
- Prof. W. Heck, NCSU
- Mr. G. Murray, Jr., NCDENR
- Mr. J. Southerland, NCDENR
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- Mr. R. McCulloch, NCDENR
- Dr. W. Cure, NCDENR
- Mr. R. Wooten, NCDENR
- Dr. R. Holman, WRRI
- Prof. D. Moreau, Chair, NC Environmental Management Commission
International Perspective
NORTH CAROLINA EXPERIENCES IN ATMOSPHERIC NITROGEN STUDIES – JUNE 7, 1999

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Abstract

Nitrogen compounds are needed as nutrients for plant growth and can be obtained by plants through soil, water, and/or air. Oxidized and reduced nitrogen compounds are two reactive forms that are emitted into the air from multiple types of sources. In North Carolina, nitrogen deposition from the atmosphere is believed to provide a substantial portion of the new nutrients entering eastern terrestrial and aquatic systems. While nitrogen compounds in the atmosphere, including ammonia, can have beneficial effects on various crops and other vegetation, excess nitrogen loading to ecosystems can cause a number of detrimental effects. These effects include eutrophication of rivers and coastal waters, decreases in biodiversity within ecosystems, and elevated nitrate concentration in ground water.

In 1996 the North Carolina General Assembly provided funding for research to provide a better understanding of the environmental impact of animal waste management in North Carolina, specifically, as it relates to ammonia emissions. The North Carolina Division of Air Quality, the US EPA and USDA provided additional support for research. In March 1997 a multinational State of Knowledge workshop was held. Fifteen measurement and modeling related projects have been completed or are in progress. Several of the initial projects involved measurements of emissions of ammonia compounds from swine lagoons in eastern North Carolina. Other projects examined the relationships between the changes in size of the animal industries and other potential source categories and the change in the amount of ammonium in rainfall. Dry deposition was estimated near swine facilities by measuring the amount of through fall of ammonium compounds from vegetation canopies. One project reviewed and modified the chemical and aerosol mechanisms for use in regional scale deposition modeling. The US EPA provided much of the support for the modeling activity and is continuing support for modeling.

The current understanding of ammonia emissions in North Carolina is summarized below:

- Animal production is a major source of atmospheric ammonia. Ambient ammonia levels have not exceeded the NC Air Toxics Acceptable Ambient Level at three sampling sites.
- Researchers have reported findings on ammonia emissions from waste lagoons. Nitrogen emissions from animal wastes are highly variable on a short time scale.
due to the influence of a number of factors, such as wind speed and temperature, and are affected by season.

- Lagoon emissions were measured with different technologies. The results agree within an order of magnitude. The results indicate lagoon emissions are in the same ranges as the emissions from swine farms in Europe as reported by US EPA.
- Studies concluded ammonium concentrations in rain are elevated in eastern North Carolina and ammonium concentrations and deposition correlate with changes in animal populations.
- Amounts of ammonia emissions from swine housing is likely similar to emissions from waste lagoons.

Significant progress has been made, but continued work is needed in the following areas: better understanding of emissions from other sources at swine farms and at other types of animal operations; determination of deposition rates for various surfaces in eastern North Carolina, including crops and forests; continued modeling work, including deposition and dispersion modeling; expanded monitoring; and a better understanding of the effects of nitrogen deposition.
EMISSIONS OF ATMOSPHERIC NITROGEN COMPOUNDS
FROM FARM ANIMALS IN CANADA

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Abstract

Ammonia and nitrous oxide are the main nitrogen compounds emitted from agricultural operations. Agricultural activities contribute an estimated 90% of ammonia and 65% of nitrous oxide emissions from all sources in Canada. Farm animal operations contribute about 80% of the total agricultural emissions of ammonia. These emissions occur from farm structures and from land application of manure. The latter is the main source of nitrous oxide emissions from animal operations. Results from Canadian studies on ammonia and nitrous oxide emissions from animal operations, and the strategies to reduce such emissions, are summarized in the paper.

During the past decade substantial increases in animal populations, particularly hogs, has occurred in Canada. In response to a need for development of environmentally sound management practices for hog production, Agriculture and Agri-Food Canada in the federal government, in partnership with the producers and the provincial governments, initiated a Hog Environmental Management Strategy (HEMS) in 1998. The objective was to develop a national approach and an action plan to address hog environmental issues. Management of nitrogen in the overall hog production systems was identified as one of the issues to be addressed. Information of the HEMS consultation process and action plan is given in the paper.
THE DEPOSITION OF AMMONIA TO SEMI-NATURAL VEGETATION,
FIELD MEASUREMENTS, MODEL SIMULATION
AND NEW MEASUREMENT APPROACHES.

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Abstract

The paper covers three aspects of the exchange of ammonia between vegetation and
the atmosphere, flux measurements using micrometeorological methods,
simulation of the fluxes using a process based model and the development of
simple, low-cost methods to obtain long term average deposition fluxes by
micrometeorological methods.

Continuous measurements of the ambient concentrations and surface-atmosphere
exchange of ammonia over semi-natural vegetation over a growing season are
reported. The measurements show the fluxes to be controlled largely by uptake into
water films on the surfaces of the vegetation, however, emission fluxes are observed
on occasion, when the canopy compensation point is exceeded.

The fluxes are used to quantify annual fluxes and, when compared with the input of
oxidized and reduced Nitrogen in precipitation and the dry deposition of HNO3 and
NO2, to quantify the relative importance of the different Nitrogen compounds to
the total input.

The field measurements are compared with modelled fluxes obtained using a
dynamic, process based model which allows the effects of chemical interaction of
SO2 and NH3 within water films on the vegetation on surface-atmosphere fluxes to
be explored.

Lastly, recent developments of simple, low-cost flux measurement methods for
ammonia, and other reactive gases are described. The methodology relies on
conditional sampling of the trace gases and measurement of the eddy diffusivity to
provide unbiased estimates of weekly or two weekly fluxes. Results of field studies
during the last year to compare these methods with conventional approaches are
reported.
INSTRUMENT DEVELOPMENT AND ITS APPLICATION IN STUDIES OF AMMONIA RESEARCH AND MONITORING

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Abstract

During recent years it has become obvious that ammonia is an important gas in relation to environmental themes such as acidification, eutrophication, human health and climate change (through particle formation). Therefore, there is a growing need to develop and apply instrumentation suitable for research on emission, dispersion, conversion and deposition of ammonia. ECN has developed several instruments suitable for measuring concentrations in ambient conditions even at very low levels, such as ammonia sensors suitable for monitoring and research, deposition measuring systems and aerosol samplers for on-line measurement of aerosol composition. These instruments have been tested and applied in a number of field studies. In this presentation, the methods and its specifications will be described. Furthermore, its application in field studies will be demonstrated and the results of these studies will be highlighted. These include measurements of ammonia emissions from animal housing systems and surface application of manure using the horizontal plume detection, deposition studies using the gradient system and the Relaxed Eddy Accumulation system, ambient ammonium and ammonia concentration monitoring for evaluation of abatement measures.
MODELLING THE EMISSION AND DEPOSITION OF AMMONIA ON VARIOUS SPATIAL AND TIME SCALES

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Abstract

Gaseous ammonia (NH₃) and its reaction product particulate ammonium (NH₄⁺) are important atmospheric components. They are collectively termed NHx. Deposition of these components may lead to eutrophication of terrestrial or marine ecosystems and to acidification of terrestrial ecosystems. Ammonium containing particles have influence on the earth's radiation balance and in this way they can influence the climate. Ammonium is not released as such, but is formed from ammonia that in Europe and North America mainly originates from animal husbandry and synthetic fertilizers.

An overview will be given on the methods to calculate the annually averaged ammonia emission on a national scale and the possibilities to reduce the emission. Moreover, the possibilities of modelling the emission with a high temporal resolution will be addressed as well as their consequences for atmospheric transport and deposition.

NHx is mainly dry deposited as NH₃ close to sources and wet deposited further away (this wet deposition originates mainly from scavenging of NH₄⁺). This means that the total deposition of NHx (sum of wet and dry) in or close to areas with a high emission density is dominated by dry deposition of NH₃ from nearby sources and that the total deposition of NHx in more remote areas is dominated by NHx originating from scavenging of NH₄⁺ aerosol that is being transported over long distances. As a consequence an atmospheric model for NHx should be able to describe processes on a local as well as a regional scale. Some results of atmospheric transport models on various scales will be presented. Moreover, attention will be paid to deposition in nature reserves and coastal areas.

Some examples of decision tools will be presented that can be used to evaluate the effect of emission reductions on depositions and their effects.
Session I
DETECTING AND REDUCING AMMONIA EMISSIONS FROM DAIRIES AND CATTLE FEEDLOTS: A REVIEW

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Abstract

Ammonia is one of 170 compounds detected in livestock manure odor. Ammonia is emitted from surfaces of open, unpaved cattle feedlots and dairy corrals at concentrations of 360-980 (g/m3 as compared to background levels of 1-4 (g/m3 in prior research. Ammonia volatilization losses are reportedly 50% or more of total N excreted from open lot surfaces and 23-70% following field spreading. Approaches to ammonia and odor control include improved manure collection and treatment processes, capture and treatment of odorous gases, and improved dispersion through site selection. Approaches to ammonia monitoring include acidic solution traps, chemoluminescence, and GC-MS.
RECENT ADVANCES IN THE STATE OF KNOWLEDGE REGARDING AMMONIA AND METHANE EMISSIONS FROM ANIMAL WASTE IN THE UNITED STATES AND IN EUROPE

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Abstract

For EPA, with co-funding from NCDENR, ARCADIS Geraghty & Miller has collected recent information on ammonia and methane emissions from manure management from swine, poultry, dairy and cattle in the United States and in Europe. Manure management sources include animal houses, storage facilities, lagoons, and sprayfields. Recent emission estimates, as well as background information on emission factors and methodologies, are discussed. This study compares European emission factors with U.S. and North Carolina emission factors from field tests and identifies data gaps in animal waste ammonia and methane emission inventory development.

Ammonia and methane emission estimates for swine operations and other significant animal waste sources in North Carolina and the United States are being developed from the newly developed emission factors, recent activity data, and previous EPA information.
AMMONIA EMISSIONS FROM SWINE WASTE OPERATIONS IN NORTH CAROLINA

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Abstract

Livestock wastes account for approximately twenty-five Teragrams of nitrogen emissions yearly from a global perspective. However, there is little information available on quantification and characterization of ammonia from domestic animal waste operations in the United States. North Carolina has the second largest swine population (over 9 million animals) in the United States. Wastes from these large swine operations along with cattle and poultry operations are significant sources of ammonia (160,000 tons per year). The total amount of ammonia produced in North Carolina is close to 175,000 tons per year. Based on emission factors developed in Europe, it is estimated that swine production contributes around 47% of this total, while the total domestic animal population (swine, cattle, and poultry) may contribute about 90%. Using a dynamic chamber system interfaced to a mobile laboratory, ammonia emission source strengths were examined on several different swine waste lagoons. Source strengths of ammonia from lagoon surfaces were found to be in the range of 700-4100 micrograms per meter squared per second during the late summer months, and 400-3200 during the fall. It was also determined that ammonia-nitrogen flux was strongly correlated to the lagoon water temperature.
FIELD MEASUREMENT OF GREENHOUSE GAS EMISSION RATES AND DEVELOPMENT OF EMISSION FACTORS FOR WASTEWATER TREATMENT

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Abstract

Greenhouse gases (GHG), including ammonia, carbon dioxide, and methane, are produced by the anaerobic decomposition of waste in landfills, septic sewage systems, lagoons, and wastewater treatment facilities. Some estimates are available for the amount of pollutants emitted from certain types of waste facilities, but there is not adequate field measurement data to validate these estimates. Therefore, field testing was performed to develop more reliable emission estimates for these sources. Field test of emissions were conducted for wastewater treatment systems that use anaerobic processes to treat large volumes of wastewater with large biological oxygen demand (BOD) loadings. Air emission and wastewater measurements were made for anaerobic lagoons at three meat processing plants and at two publicly-owned treatment works (POTWs). The overall emission rates of methane, carbon dioxide, carbon monoxide, nitrous oxide, ammonia, and chlorofluorocarbons (CFCs) were measured from each source using an open path monitoring approach. The emitted compounds were identified and quantified by Fourier Transform Infrared (FTIR) spectroscopy. Emission factors were developed for methane and ammonia as a function of the plant production rate, influent BOD loading, etc. This paper will provide an overview of this research and discuss issues associated with available data and estimates of GHG emission rates for wastewater treatment.
AMMONIA EMISSIONS FROM FIELD APPLICATIONS
OF POULTRY MANURE

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Abstract

Ammonia emissions from poultry manure are a potential source of atmospheric N compounds in the Mid-Atlantic region, as well as an economic loss of plant available N to the farmer. Results from two field micrometeorology studies will be discussed which utilized the integrated horizontal flux method. These studies employed: a 40 meter diameter circle, six point conventional acid-trap samplers, and cup anemometers to quantify ammonia emissions from an application of 9 tons per hectare of poultry manure spread on the soil surface. Field experiments were conducted in the fall (late October) and spring (early March) to document ammonia losses associated with the use of poultry manure in a winter wheat cropping system. Results show losses of 15-50 percent of the poultry manure ammonium-N, which are lower losses than predicted from current agricultural nutrient management programs, and are important sources of ammonia to the atmosphere.
MEASURING CHEMICAL EMISSIONS USING ENVIRONMENTAL CAT SCANNING

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Abstract

Ammonia emissions from a waste lagoon at a swine facility were measured using a new technology that combines open-path Fourier Transform Infrared Spectroscopy (OP-FTIR) with computed tomography. This technology allows "real-time" maps of chemical concentrations and plumes in air to be reconstructed for the entire surface of the lagoon. Two rotating OP-FTIR spectrometers and 12 retroreflectors were placed on the periphery of the lagoon and infrared beams were shot across the lagoon every few seconds. Measurements were obtained within one meter of the surface of the lagoon. Real-time concentration maps were generated every two minutes during the day and during some evenings over several seasons. To calculate the ammonia emissions, neutrally buoyant sulfur hexafluoride (SF6) was used as a tracer gas and was released at known emission rates from the center of the lagoon. Both SF6 and ammonia were measured simultaneously and the concentrations and emission rates of SF6 were used to calculate the ammonia flux. The lagoon was represented as a 3x7 grid and fluxes were calculated for each grid cell. Average ammonia fluxes for data collected in November 1997 and May 1998 were – 2000 and 7000 ug/m2-min, respectively.
Estimating ammonia emissions in North Carolina is dependent upon the availability of credible emission factors. While such factors are available for many combustion processes that result in the emission of oxidized nitrogen (NO_x-N), those for ammonia that have been compiled by the USEPA have mainly been derived from European research and a very few US studies. Using these factors, estimates of total ammonia-N emissions in North Carolina for 1996 were in excess of 130,000 tons (120,000 metric tons), about 40% of the total N emissions of almost 335,000 tons. Emissions from swine operations, estimated at more than 77,000 tons, alone account for nearly 60% of the ammonia-N total. By comparison, NO_x-N emissions from large point sources, primarily utility boilers, were nearly 92,000 tons the same year. How estimates of ammonia-N change with different estimation methods will be discussed as will the distribution of these emissions across the state.
ESTIMATING AMMONIA EMISSIONS FROM REMOTELY SENSED DATA

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Abstract

Atmospheric ammonia (NH\textsubscript{3}) emissions from agricultural intensive livestock operations (ILO) waste treatment lagoons have been modeled by Aneja, et al, (1997, 1999) based on lagoon surface water temperature. Air and water surface temperatures from the surface treatment lagoon were then used to build a prediction equation that estimates water temperatures for given air temperatures. A time series model was then used to enhance water temperature predictions. These estimated water temperatures were then used as inputs into the ammonia emissions model, which subsequently simulated the hourly emissions of ammonia. Confidence intervals were constructed on the predictions to realize the uncertainty in the estimates. In order to compute the hourly emissions for several waste lagoons, lagoon surface areas were estimated using aerial photographs from the North Carolina State University (Libraries) SPOT GIS database. Finally, simulated seasonal emissions were computed from remotely sensed air temperatures for Eastern North Carolina and compared to ammonia emissions obtained from emissions factors.
AMMONIA-NITROGEN EMISSIONS IN NORTH CAROLINA - COMPARISON AMONG ESTIMATES WITH DIFFERENT EMISSION FACTORS

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Abstract

Estimating ammonia emissions in North Carolina is dependent upon the availability of credible emission factors. While such factors are available for many combustion processes that result in the emission of oxidized nitrogen (NOx-N), those for ammonia that have been compiled by the USEPA have mainly been derived from European research and a very few US studies. Using these factors, estimates of total ammonia-N emissions in North Carolina for 1996 were in excess of 130,000 tons (120,000 metric tons), about 40% of the total N emissions of almost 335,000 tons. Emissions from swine operations, estimated at more than 77,000 tons, alone account for nearly 60% of the ammonia-N total. By comparison, NOx-N emissions from large point sources, primarily utility boilers, were nearly 92,000 tons the same year. How estimates of ammonia-N change with different estimation methods will be discussed as will the distribution of these emissions across the state.
NPPC's ON FARM ODOR/ENVIRONMENTAL ASSISTANCE PROGRAM

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Abstract

In June of 1996 the National Pork Producers Council decided that a major obstacle to expansion and continued profitability of the swine industry in the United States was environmental risk, both real and perceived. In order for the industry to expand and continue to prosper environmental issues needed to be address in a proactive manor. Thus, the leadership of NPPC requested Checkoff funds from the Pork Board to fund two new initiatives to address environmental issues.

The first program the On Farm Odor/Environmental Assistance Program (OFO/EAP) and the second the Odor Solutions Initiative (OSI). The OFO/EAP program is designed to address management related issues by suggesting Best Management Practices (BMP's) to deal with the environmental challenges. This program is a one on one educational opportunity for the producer during the assessment. Specially trained assessors use the opportunity to explain why things may be an environmental challenge and why a particular BMP may work. The program identifies strengths as well as challenges. This program has assessed a few hundred farms with some interesting results. One important component of this program is the database that is being created to track environmental information on the participating farms. This type of information on a large scale does not exist. The information from the database will be used to determine the things common to operations that have problems, but it will also identify the things that are common among those with no problems.

The OSI program has several components. One component is testing of measures, gathering information for a database and use of information to do some air modeling. Other components involve column testing of additives, evaluation of waste treatment and potential evaluation of variations to swine diets. This program is in its very early stages and will be reporting results some time in the next couple of years.
TRANSPORT, DEPOSITION, AND EFFECTS OF NOX EMISSIONS FROM
THE U.S. ELECTRICITY SECTOR UNDERGOING
RESTRUCTURING: NITROGEN DEPOSITION AND OZONE
FORMATION IN THE CHESAPEAKE BAY WATERSHED REGION

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ABSTRACT

Competition in and restructuring of electricity markets could result in substantial changes in NOx emissions from power plants. This report focuses on how three potential restructuring scenarios and four EPA NOx reduction regulatory scenarios could affect NOx emissions from power plants, and resultant nitrogen loadings and ozone formation in the Chesapeake Bay watershed. The report draws on: 1) a national electricity model to characterize NOx emissions changes that could occur, and 2) unique application of EPA's CALPUFF model to evaluate deposition impacts and to begin to evaluate potential impacts to regional ozone formation.

Modeling predicts only small overall changes in total nitrogen deposition and loading rates to the Bay watershed from market restructuring. At most, the aggressive restructuring scenarios result in an up to 3.0% increase in nitrogen deposition and loading rates to the Bay watershed from the baseline restructuring scenario. The degree to which projected modest increases in nitrogen deposition affect overall water quality is expected to be small; however, even small increases in deposition may be significant in Bay tributaries with relatively tight nitrogen budgets.

We also use CALPUFF-predicted NOy as an indicator of potential ozone. Results suggest that ozone formation rates track changes in emission rates, but to a lesser degree than deposition quantities. Even under stringent NOx control scenarios, the increase in potential ozone due to restructuring is a significant fraction of the increases predicted for restructuring under the base case NOx control scenario; the increases are nonetheless modest.
A NEURAL NETWORK MODEL TO ESTIMATE AMMONIA IN THE ATMOSPHERE

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Abstract

Atmospheric ammonia (NH₃) along with sulfur dioxides (SO₂), and nitrogen oxides (NOₓ) has recently come to the attention of scientists primarily due to acidification and eutrophication of ecosystems. To improve air quality, it is really required to estimate the exact ammonia emissions and the wide range of studies about ammonia. Most recently, many scientists have devoted their attention to this issue. However it is difficult to estimate emissions in the atmosphere under complex conditions because ammonia emissions depend on some various influencing factors.

In this study, to estimate pollutants which are produced or reduced non-linearly under complicated chemical reactions and various meteorological conditions, we used the neural network model which favorably simulates pollutants which have non-linear relations with each other.

Input variables for the model include the target ammonia data in the atmosphere, meteorological data (relative humidity, solar radiation, air temperature, wind speed, and direction), the population of hogs, ammonia flux, and NOₓ (NOₓ + HNO₃ + PAN + HNO₂ + NO₃ + organic nitrates) data from hog farm lagoons at the same site and same time. Ammonia flux from hog farm lagoons is one of the most important input data to estimate the target ammonia concentration in the atmosphere at the same region. This model is also useful to evaluate the importance of different single factors in the complex system that has influence on ammonia concentration.
MULTI-POLLUTANT CONCENTRATION MAPPING AROUND A
CONCENTRATED SWINE PRODUCTION FACILITY
USING OPEN-PATH FTIR SPECTROSCOPY

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Abstract

Open-path Fourier Transform Infrared (OP-FTIR) spectroscopy has been used
to map pollutant concentrations around a integrated industrial swine production
facility in eastern North Carolina. Single measurement paths were located to
separate the emissions from the farrowing and finishing operations as well as the
waste water lagoon. Ammonia, methane, carbon monoxide, carbon dioxide, nitrous
oxide and water vapor were found to be slightly to highly elevated above the local
background. Hydrogen sulfide and mercaptans were not detected. Complex air flow
in and around the production houses has not allowed calculations of emission rates
using simple flow models. The concentration data suggest that the production
houses can be a significant source of atmospheric ammonia and the lagoon a major
source of methane. Measurements of the mechanical exhausts from the finishing
barns indicate little seasonal variability of the estimated ammonia emissions.
TRENDS IN AMMONIUM CONCENTRATION IN PRECIPITATION AND LOCAL AMMONIA EMISSIONS AT A COASTAL PLAIN SITE IN NORTH CAROLINA, USA

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Abstract

The temporal characteristics of ammonium (NH$_4^+$) ion concentration in precipitation and local ammonia (NH$_3$) emissions are investigated over the period 1982-1997 at National Atmospheric Deposition Program/National Trends Network site NC35, located in Sampson County, North Carolina. Multiple regression analysis of annual volume-weighted values of NH$_4^+$ concentration in precipitation identifies a statistically significant (p<0.01) 4-year cycle and increasing trend during the period. The cycle is likely a function of mean annual surface temperature, which is shown to be a significant (p<0.01) predictor variable for annual NH$_4^+$ concentrations in precipitation. Regression analysis of monthly volume-weighted NH$_4^+$ concentration is used to illustrate a significant (p<0.01) increasing trend of approximately 0.083 mg NH$_4^+$ 1$^{-1}$ yr$^{-1}$ over the period 1990-1997 (period 2) and lack of trend during the period 1982-1989 (period 1). An analysis of annual NH$_3$ emissions from individual sources in an intense agricultural region surrounding NC35 shows that emissions from cattle and fertilizer were not significantly different (1% level) across the two periods, while emissions from chickens were significantly (p<0.01) lower during period 2. Turkey and broiler emissions are believed to be constant across both periods. Swine emissions were the only source which was significantly greater (p<0.01) during period 2. Local ammonia emissions from swine and mean surface temperature explain approximately 95% of the variation in annual volume-weighted NH$_4^+$ concentrations in precipitation at NC35 during the period 1982-1997.
ATMOSPHERIC CONCENTRATIONS OF AMMONIA AND AMMONIUM AEROSOLS IN Sampson County, North Carolina

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Abstract

Fate and transport of ammonia (NH₃) emitted from effluent lagoons, housing units, or land application of animal wastes (effluent or litter) is dictated in part by partitioning between ammonia and ammonium aerosols (e.g., NH₄NO₃, NH₄HSO₄, NH₄Cl) in the atmosphere. Annular denuder technology is being used to measure the atmospheric concentrations (sampling height = 2.6 m) of ammonia and ammonium aerosols in Sampson Co., NC, where there is a relatively high density of large-scale swine and poultry production facilities. From May 1, 1998 to July 1, 1998, mean day time (0700-1900 h) concentrations of ammonia expressed as nitrogen were 4.97 (+/- 1.74) µg m⁻³. Mean nighttime (1900-0700 h) concentrations of ammonia were 7.52 (+/- 4.58) µg m⁻³. From October 14, 1998 to December 15, 1998, mean daytime concentrations of ammonia ranged from 5.4 to 0.3 µg m⁻³. Day-to-day variations in atmospheric ammonia concentrations appear to be related to changes in atmospheric temperature. Ammonium aerosols account for less than 50% of the ammonia species in the atmosphere. This research is part of a larger effort in cooperation with U.S. EPA, NOAA and UNC-IMS to calibrate and evaluate model projections of the fate and transport of ammonia in eastern North Carolina.

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Session III
SOURCE-RECEPTOR MODELING OF WET AMMONIUM DEPOSITION IN NORTH CAROLINA, USA

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Abstract

A source-receptor regression model is developed to statistically test for the influence of a particular North Carolina (NC) Coastal Plain ammonia (NH$_3$) source region on ammonium (NH$_4^+$) concentrations in precipitation at surrounding NC National Atmospheric Deposition Program/National Trends Network (NADP/NTN) sites during the period 1995-1996. The model used daily precipitation information and weekly precipitation chemistry samples collected at NADP/NTN sites in conjunction with boundary-layer air mass back trajectories calculated using version 4 of the HYSPLIT model. The source region is defined as the combined area of the six NC counties with the largest hog population densities (average = 530 hogs km$^{-2}$). Ammonia emissions from swine and turkey populations in this region amount for approximately 70% and 50% of total statewide emissions from each source, respectively. Results show that NH$_3$ emissions from this source region are found to increase NH$_4^+$ concentration in precipitation at NADP/NTN sites up to = 80 km away. At the Scotland County (NC36) and Wake County (NC41) sites, mean NH$_4^+$ concentrations in precipitation show increases of at least 44% for weeks during which 25% or more back trajectories are influenced by this source region.
ESTIMATION OF ATMOSPHERIC DEPOSITION OF AMMONIUM AND NITRATE IN NORTH CAROLINA AND COASTAL PLAIN RIVER BASINS

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Abstract

The specific objective of this paper; as part of a larger research plan to assess the environmental impacts of animal agriculture operations, was to develop spatially refined estimates of atmospheric deposition of ammonium and nitrate to river basins of North Carolina over time. Three different sources of information were utilized: 1) National Atmospheric Deposition Network (NADP) and Clean Air Status and Trends Network (CASTNet) data on amounts of ammonium ion (NH4+) and nitrate ion (NO3-) deposited as rain and snow; 2) National Weather Service data on amounts of precipitation; and 3) CASTNet estimates of amounts of dry deposition of NH4+ and NO3-deposited as atmospheric gases and particles. The data were integrated within a Geographic Information System-based framework delineating the river subbasins in North Carolina, using interpolation techniques to produce estimates for a 5 X 5 km grid. Because of limitations of funding, this initial analysis concentrated on only two years, 1989 and 1994.

We conclude from the analyses that: a) a substantial part of the scientific evidence is consistent with the hypothesis that recently increased populations of swine in NC have contributed to an increased transfer of NH4+ from the atmosphere to land and surface waters of the state, and b) a less substantial part of the evidence is not fully consistent with this hypothesis.

Five steps in further analyses are recommended: a) utilizing data for all years of the historical record, b) checking the temporal and geographical representativeness of NADP and CASTNet sites, c) conducting more detailed time-series analyses at all sites, d) considering dry deposition more adequately, and e) using nutrient deposition data as a critical test of emissions inventory methods.
ATMOSPHERIC DEPOSITION ESTIMATES OF NITROGEN TO THE ATLANTIC AND GULF COASTS OF THE UNITED STATES

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Abstract

General estimates have been developed for atmospheric deposition of nitrogen on coastal and estuarine waters of the eastern United States Atlantic Ocean and Gulf of Mexico. This study set out to develop and apply a methodology for using data collected by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) monitoring network to calculate estimates of atmospheric deposition of nitrogen to coastal waters. The methodology was developed to generate estimates of direct wet and dry deposition of ammonium, nitrate, and total inorganic nitrogen to surface waters and indirect deposition of nitrogen to surface waters.

The findings presented in this report reflect the completion of the first part of this study - the calculation of direct wet deposition of ammonium, nitrate, and total inorganic nitrogen to coastal and estuarine waters of the U.S. portions of the Atlantic coast and the Gulf of Mexico.

The general approach for defining the study area was to generate an initial zone from the shoreline, extending a specified distance out into the ocean. This zone was segmented for estimation and reporting purposes based on the National Oceanic and Atmospheric Administration’s (NOAA) Coastal Assessment Framework (CAF), an existing digital set of spatial areas developed by NOAA’s Strategic Environmental Assessments (SEA) Division.

Annual and seasonal deposition data available from NADP/NTN were used to estimate direct loadings and concentrations of nitrogen from wet deposition. A Thiessen algorithm was used to define the area for which data collected at each NADP station are valid. Direct wet deposition loads of nitrate, ammonium, and total inorganic nitrogen and the concentrations of these species in rainfall were derived from NADP/NTN data. This analysis extrapolates data from monitoring sites to generate estimates for coastal and estuarine surface water segments.
STABLE NITROGEN ISOTOPIC TRACERS OF SOURCES
OF NITROGEN IN WET DEPOSITION ON THE
NORTH CAROLINA COASTAL PLAIN

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Abstract

Human activities have increased the concentration of nitrate in ground waters and increased the loading of new nitrogen in rivers, estuaries and coastal waters. The pollution of the hydrosphere and the atmosphere by compounds of nitrogen is a problem that is a population-increase driven component of global change. North Carolina and NOx and NH4 wet deposition have been studied. This is in contrast to the NH4 urban/NOx rural distinction which show a marked increase in NH4 in selected levels of ammonium ion deposition.

To distinguish between urban and rural sources, the $^{15}$N isotopic composition of NH$_4$ in rainfall from Raleigh, NC and a swine farm in Sampson County, NC was monitored to determine if ammonium deposited as wet deposition has a different isotopic signal at an urban and farm site. The average isotopic composition of ammonium in rainfall at the Sampson County collector was 8.4 per mil with a standard deviation of 3.92 per mil. The average isotopic composition of ammonium in rainfall collected at Raleigh was 4.9 per mil with a standard deviation of 2.1 per mil. The ammonium concentration in the Sampson County rainfall was twice as high as in Raleigh rainfall, but the Raleigh rainfall contained more nitrate. Isotopically, the most negative ammonium was found during the winter months at the farm site. The highest concentrations of ammonium was found in the rain at the farm site during the summer months. This data suggests that the nitrogen isotopic composition of ammonium in rainfall can be used successfully to determine the extent of atmospheric deposition of nitrogen derived from animal waste lagoons. Future work should include the isotopic characterization of coastal rainfall as well as a comparison of dry and wet deposition.
SEASONAL VARIATIONS OF NITRIC OXIDE
FLUXES FROM DIVERSE PHYSIOGRAPHIC
AGRICULTURAL SOILS IN NORTH CAROLINA

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Abstract

Emissions of nitric oxide (NO) were determined during late spring and summer 1995 and the spring of 1996 from four crop types, located at four different physiographic regions in North Carolina. Emission rates were calculated using a dynamic flow-through chamber system coupled to a state-of-the-art mobile laboratory for in-situ analysis. Average NO fluxes during late spring 1995 were: 50.9 ± 47.7 ng N m⁻² s⁻¹ for corn in the lower coastal plain. Average NO fluxes during summer 1995 were: 6.4 ± 4.6 and 20.2 ± 19.0 ng N m⁻² s⁻¹ respectively for corn and soybean in the coastal region; 4.2 ± 1.7 ng N m⁻² s⁻¹ for tobacco in the piedmont region; and 8.5 ± 4.9 ng N m⁻² s⁻¹ for corn in the upper piedmont region. Average NO fluxes for spring 1996 were: 66.7 ± 60.7 ng N m⁻² s⁻¹ for wheat in the lower coastal plain; 9.5 ± 2.9 ng N m⁻² s⁻¹ for wheat in the coastal plain; 2.7 ± 3.4 ng N m⁻² s⁻¹ for wheat in the piedmont region; and 56.1 ± 53.7 ng N m⁻² s⁻¹ for corn in the upper piedmont region. An exponential dependence of NO flux on soil temperature was present at all of the locations. Further, all locations displayed a diurnal trend of NO emissions which revealed a peak in NO emissions that coincided with the maximum soil temperature for the day. The composite data of all the research sites revealed a general positive trend of increasing NO flux with soil water content and extractable nitrogen.
NITRIC OXIDE FLUX FROM SOIL AMENDED WITH MUNICIPAL WASTE WATER BIOSOLIDS: A STATUS REPORT

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Abstract

The flux of nitric oxide (NO) from soil amended with municipal waste water biosolids is studied in ongoing laboratory experiments and field observations. Much of the more than six million dry metric tons of municipal waste water biosolids produced annually nationwide is not contaminated with harmful heavy metals or persistent organics and thus potentially is useful as a nitrogen fertilizer and soil conditioner. The attraction is to take advantage of the benefits of these materials while protecting public health and the environment; if NO flux from municipal waste water biosolids-amended soil is less than the NO flux from chemically fertilized soil the argument for expanding the practice of spreading municipal waste water biosolids to soil would be enhanced; if NO flux from municipal waste water biosolids-amended soil is greater than NO flux from chemically fertilized soil the argument for expanding the practice of spreading municipal waste water biosolids to soil would not be enhanced.

Newly developed laboratory equipment and ongoing procedures are discussed and the results of preliminary laboratory NO flux experiments are summarized in terms of selected soil temperature and moisture conditions. The laboratory results will be compared to scheduled field observations and evaluated in terms of atmospheric transport, transformation and fate of NO and subsequent ozone formation.
NITRIC OXIDE FLUX FROM SOIL AMENDED
WITH MUNICIPAL WASTE WATER

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Abstract

The flux of nitric oxide (NO) from soil amended with municipal waste water is studied in laboratory experiments and compared to NO flux from un-amended soil. Land application of municipal waste water is practiced throughout the US in efforts to dispose of the waste water while reclaiming the water and its nutrients for non-food chain and human food chain crop production. Historically nitrogen losses from these engineered soil systems have been discussed only in terms of liquid migration to surface and subsurface water supplies. The focus of this research is on the loss of gaseous nitrogen to the lower levels of the troposphere with the attendant problem of ozone formation.

Newly developed laboratory equipment and procedures are presented and discussed, and the results of experiments are summarized. These results indicate that NO flux from an un-amended sandy loam soil at field moisture ranges from 0.3 to 0.4 ngN/m²s, NO flux from soil of different moisture contents ranges from 0.4 to 0.7 ngN/m²s, and NO flux from soil amended with municipal waste water ranges from 1.0 to 1.2 ngN/m²s. These results are compared to other research efforts which focus on field observations of NO flux from agricultural soil.
NITROUS OXIDE EMISSION FROM A SPRAY FIELD FERTILIZED WITH LIQUID SWINE EFFLUENT

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Abstract

Contemporary agriculture is characterized by the intensive production of livestock in confined facilities and land-application of stored waste as an organic fertilizer. Emission of nitrous oxide (N₂O) from receiving soils is an important, but poorly constrained term in the atmospheric N₂O budget. In particular, there are few data for N₂O emissions from spray fields associated with industrial scale swine production facilities that have rapidly expanded in the southeastern United States. In an intensive, 24 d investigation over three spray cycles, we followed the time course for changes in N₂O emission and soil physicochemical variables in an agricultural field irrigated with liquid lagoonal swine effluent. The total-N (535 mg L⁻¹) of the liquid waste was almost entirely NH₄⁺-N (>90%) and thus had a low mineralization potential. Application of this liquid fertilizer to warm (19 to 28°C) soils in a form that is both readily volatilized and immediately utilizeable by the endogenous N-cycling microbial community resulted in a sharp decline in soil NH₄⁺-N and supported a rapid and short-lived (days) burst of nitrification, denitrification and N₂O emission. Nitrous oxide fluxes as high as 9200 µg N₂O-N gₐₖₚₐₜₜ soil⁻¹ h⁻¹ were observed shortly after fertilization, but emissions decreased to prefertilization levels within a few days. Total fertilizer N applied and N₂O-N emitted were 29.7 g m⁻², and 395 mg m⁻², respectively. The fractional loss of applied N to N₂O (corrected for background emission) was 1.4%, in agreement with the mean of 1.25% reported for synthetic fertilizers. The direct effects of fertilizer application appear to be more immediate and short-lived for liquid swine waste than for manures and slurries that have a slower release of nitrogenous nutrients.
CONTROLLED ON DENITRIFICATION RATES IN SOILS
FERTILIZED WITH LIQUID SWINE EFFLUENT

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Abstract

Two approaches were used to characterize physicochemical factors which affect the rate of denitrification in soils from a representative, effluent-amended agricultural field. First, intact soil cores (0 to 20 cm) were amended with effluent at three different loading rates in laboratory incubations. Fertilization produced a short-lived (1 to 2 d) burst of denitrification, with rates as high as 11,000 μg N m⁻² h⁻¹ recorded (acetylene block technique) for the highest dose. Overall, higher doses gave higher rates of denitrification and prolonged the duration of the elevated gaseous N flux (N₂ + N₂O). Denitrification rates returned to pre-fertilization levels after a few days, despite NO₃⁻-N accumulation in the soil. This suggested that other factors might be rate-limiting in the short term. Therefore, the second component of this study focused on the effects of individual physicochemical variables (soil moisture, temperature, labile-C and NO₃⁻-N) on the rate of denitrification in homogenized soils in a laboratory setting. Moisture (a proxy for aeration status) significantly affected denitrification, as rates increased exponentially with increasing % WHC and leveled off at saturation. Nonetheless, appreciable rates of denitrification were observed at low soil moistures, highlighting the importance of denitrification at anaerobic microsites. In the presence of added labile-C or NO₃⁻-N, denitrifying enzyme activity (DEA) was stimulated 5 to 20-fold and by as much as 50-fold when the two treatments were combined. The temperature dependence of DEA followed a third order polynomial characteristic of microbial processes. An average Q₁₀ value of 1.9 was calculated for DEA from an exponential fit of rates to temperature data over the range 7 to 35°C.
Session IV
COMPREHENSIVE MODEL TO STUDY ATMOSPHERIC NITROGEN COMPOUNDS

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Abstract

While much attention has been devoted to studying the role of oxides of nitrogen in the atmosphere and towards reducing their emissions, there has been little focus on the cycling of reduced nitrogen compounds (denoted NHx) in the atmosphere. The modeling of NHx cycling in the atmosphere is a relatively unexplored area of research. The primary confounding factors limiting such investigations have been the lack of understanding of the sources, sinks, and chemical coupling of NHx compounds in the atmosphere. The anthropogenic emissions of NH3 are still rather poorly quantified, while natural emissions are virtually unknown. Because NH3 emissions tend to be on the local to regional scale and the lifetime of NH3 is on the order of hours, the modeling framework adopted to study its cycling must have sufficient resolution. A model for the atmospheric behavior of NHx must also account for its interactions with aerosols and be able to describe both the atmospheric transport of NH3 near a source and the transport of NH4+ over long distances.

In order to synthesize the current knowledge of the processes governing the fate of NHx in a consistent modeling framework, the Regional Acid Deposition Model (RADM) was enhanced by adding several additional modules to represent the various atmospheric physical and chemical pathways governing the fate of emitted NH3. The resulting version of the model is referred to as the Extended-RADM. The model has the ability to dynamically represent the various competing processes that interact to influence the cycling of reduced and oxidized forms of nitrogen and their interactions. Model applications over the eastern United States using 80-km grid resolution will be discussed. Preliminary predictions of the NH3/NHx ratio will be given. Preliminary model performance evaluations based on comparisons of model predictions (of both ambient levels as well as wet deposition amounts) with measurements and previous model simulations will be presented.
NITROGEN DEPOSITION AIRSHEDS FOR THE PAMLICO SOUND WATERSHEDS: DEVELOPMENT FOR OXIDIZED NITROGEN AND PRELIMINARY ESTIMATE FOR REDUCED NITROGEN

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Abstract

Atmospheric deposition of nitrogen is considered to be an important contributor to nitrogen loading of coastal estuaries. The loading comes (a) indirectly to the estuary through deposition first to the watershed and then release into streams and rivers and (b) directly to the estuary surface. Not only do we need to know the loading from the atmosphere to the watershed and estuary, but we also need to know from where the majority of deposition is coming, if we are interested in doing something about it. We use the concept of a principal airshed to define such a geographic region. We would like to know how big are the airsheds. Two principal forms of nitrogen explain the majority of deposition, oxidized nitrogen and reduced nitrogen. We expect differences between airsheds for oxidized nitrogen and reduced nitrogen because the former is associated with secondary products of photochemistry and the latter is associated with direct emissions. We would also like to know how different are the airsheds for the two principal forms of atmospheric nitrogen loading. The methodology developed for Chesapeake Bay is used to construct answers to these questions. A map of the Pamlico airshed for oxidized nitrogen, based on analyses with RADM, will be presented. The continental area, percent of oxidized nitrogen deposition explained and emissions density for the airshed will be given. For perspective, the Pamlico airshed will be compared with airsheds defined for Delaware Bay, Altamaha Sound, and Chesapeake Bay. Preliminary comparisons between the range of influence of oxidized nitrogen and reduced nitrogen, based on the Extended RADM, for select emissions regions will be presented. Assuming the average relation holds across space, a preliminary estimate of the reduced nitrogen airshed for Pamlico watershed will be presented.
MEASUREMENT OF AMMONIA/AMMONIA FLUX AND
DRY DEPOSITION VELOCITY ABOVE NATURAL
SURFACES IN EASTERN NORTH CAROLINA

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Abstract

Until recently ammonia has been relatively ignored as a primary pollutant in the United States. There have been some recent advances in the ambient concentration measurement of technology, specifically continuous-flow denuders, that have made it possible to accurately determine dry deposition rate of ammonia and its primary atmospheric reaction product, aerosol ammonia. Due to rapid growth of animal (hog) farms, eastern North Carolina experiences higher level of ammonia and ammonium. The primary focus of our work will be on the vertical fluxes of ammonia and ammonium and their dry deposition velocities over natural surfaces downwind of some typical natural/anthropogenic sources in eastern North Carolina.

Ambient ammonia concentrations are measured using traditional annular denuder systems and the continuous-flow wet denuder system. Ammonia concentration, temperature, and velocity measurements are made at two heights above the canopy/surface. The gradient method and the modified Bowen ratio method are used to estimate the sensible heat flux and ammonia flux. Dry deposition velocity ($v_d$) is estimated using the following definition: $v_d = \frac{F_c}{\bar{c}}$ where $F_c$ is the total flux of the tracer mass (i.e. ammonia) and $\bar{c}$ is the mean concentration of the tracer mass near the surface.

The result of the experiment will provide improved parameterization of dry deposition of ammonia and ammonium in regional air quality models, which can be used to determine transport, transformation, and deposition of atmospheric nitrogen compounds in eastern North Carolina.
QUANTIFICATION OF ATMOSPHERIC NITROGEN DEPOSITION IN EASTERN NORTH CAROLINA USING THROUGHFALL AND BULK DEPOSITION COLLECTORS

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Abstract

No historical records exist for the dry deposition of ammonia (NH₃) and ammonium aerosols in eastern North Carolina. Throughfall and bulk deposition collectors were used to obtain an indirect estimate of dry deposition of nitrogen (N) to deciduous forest canopies in the immediate vicinity of a large-scale swine production facility (Eastern Farm site) in the Neuse River Basin, and along a NE-SW transect from Goldsboro, NC to the Bladen State Forest. At the Eastern Farm site, NH₄-N dry deposition was approximately 2x (10.2 kg N ha⁻¹) that from wet deposition during the period August 6, 1997 to April 16, 1998. Enhanced dry deposition of chloride (9.2 kg Cl⁻ ha⁻¹) and sulfate (17.1 kg SO₄²⁻ ha⁻¹) was also associated with the dry deposition of NH₄-N. Total N loading at forested sites along the transect ranged from 7.2 to 13.1 kg N ha⁻¹ for canopies < 3 kms of animal production facilities versus 3.8 to 5.2 kg N ha⁻¹ for canopies > 5 kms from such facilities. Enhanced dry deposition of Cl⁻ and SO₄²⁻ was also observed for canopies < 3 kms of animal production facilities. This research demonstrates that use of bulk deposition and throughfall collectors provides one means to access the potential of enhanced dry deposition of N in eastern North Carolina due to the presence of a relatively high-density of animal production facilities.

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Session V
ATMOSPHERIC NITROGEN DEPOSITION TO THE NEUSE RIVER BASIN: 
ANNUAL BUDGET AND SPATIOTEMPORAL VARIABILITY

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Abstract

Atmospheric nitrogen deposition through both wet and dry deposition of NOy, NH3/NH4+, and organics may contribute up to 30% of the total N flux to the waterways of the Neuse River watershed and AD-N sensitive waters such as the Neuse River Estuary (1996-1998). Deposition varies among sites in nutrient and algal community composition and function (harmful algal blooms), hypoxia/anoxia, and fish kills. In an ongoing study, we quantified the weekly wet and dry deposition of inorganic and organic N at ten sites on a northwestern-southeast transect in the watershed from 1996 to 1998. Data from an earlier study and preliminary organic data from this study showed that the DON flux in the coastal region is approximately 20% of the total wet AD-N flux. Deposition varied by up to 4 orders of magnitude, with the mean total (wet DIN + dry DIN + wet organics) AD-N flux estimated at 2026 mg/m2/yr (32,493 tonnes/yr). Seasonally, the highest total weekly N deposition occurs during the summer months, this does not mirror the seasonal precipitation patterns and is likely driven by a combination of other meteorological forcing factors and seasonal changes in N emissions. Conservative estimates of wet deposition suggest that this flux contributes up to 30% of the total N loading to the waterways of the basin.
THE ROLE OF ATMOSPHERIC N DEPOSITION IN COASTAL EUTROPHICATION: CURRENT ISSUES AND PERSPECTIVES

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Abstract

The atmosphere is a large and growing source of nitrogen (N) enrichment in N-sensitive estuarine and coastal waters experiencing accelerating algal production (eutrophication) and water quality declines (hypoxia, toxicity, fish kills, etc.). Regionally and globally, urbanization, agricultural and industrial growth in coastal airsheds are responsible for chemically-diverse N emissions; long-term (>10 years) atmospheric deposition records (NADP) indicate that specific forms of atmospheric N are increasing at relatively high rates. In particular, ammonium (NH₄⁺) deposition associated with expanding livestock operations and their N-rich wastes has increased. Both increases in and changing proportions of various new N sources play roles in the structuring of algal communities, and may promote major biotic changes, including the proliferation of nuisance blooms. We are examining group-specific responses of the phytoplankton community (species composition, productivity) to a range of anthropogenic N compounds, including those in atmospheric deposition, in the eutrophying N-limited Neuse River-Estuary and adjacent Atlantic coastal waters. This research approach provides the functional nexus between increasing and changing forms of anthropogenic N loading, accelerating primary production and alterations at the base of coastal food webs, features commonly observed but not well-understood in eutrophying coastal waters. Results are applicable to nutrient assessment and management in geographically-diverse coastal waters experiencing various symptoms of nutrient over-enrichment.
AN OBSERVATION-BASED GAUSSIAN DISPERSION MODEL 
FOR DETERMINING AMMONIA EMISSIONS 
FROM A COMMERCIAL HOG FARM

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Abstract

In recent years, a great deal of attention has been given to the emissions and fate of nitrogen compounds in North Carolina, particularly with respect to ammonia emissions from livestock production facilities. Unfortunately, there is a general lack of reliable emission factors for these facilities. Several researchers have undertaken efforts in cooperation with the North Carolina Division of Air Quality to obtain more reliable estimates of ammonia emission factors, especially in terms of diurnal and seasonal variability.

In 1997, the Division of Air Quality installed two chemiluminescent ammonia monitors at a commercial hog farm where researchers had been measuring ammonia emissions, and meteorological measurements were being made. These concentration and meteorological measurements have been applied to a site specific gaussian dispersion model to back-calculate ammonia emission fluxes. The geometric qualities of this model allow the examination of the waste lagoon and the animal housing units; as a whole source or separately, depending upon wind direction.

Results are presented for diurnal and seasonal variability of the combined sources, and the relative source strengths of both the waste lagoon and the animal housing units. The source strengths are also examined with respect to meteorological variables.
DEVELOPING MULTI-MEDIA COUPLINGS TO LINK AMBIENT METEOROLOGICAL INFORMATION WITH THE DEPOSITION SURFACE ENVIRONMENT

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Abstract

Deposition of a chemical specie, such as nitrogen or any other VOC, is strongly dependent on the surface conditions. Humid surfaces and warmer surfaces tend to be good sinks for atmospheric pollutants. Indeed estimates for deposition flux rely on the surface conditions such as relative humidity and wetness, particularly for vegetative surface such as lawns in urban environment and agricultural lands in rural settings. For most cases, the data used for estimating these thermodynamic conditions are from the ambient measurements made at 2m above the surface (tower observations or model analysis). We test the hypothesis that the surface environment can be significantly different than the ambient environment. We then develop relations that would link the multi-media setting of air and the depositing surface boundary layer using a set of closed equations. These physiologically-based coupling relations are linked in a atmospheric boundary layer model and tested for different humidity estimates in the atmosphere and the corresponding surface humidity. Sample calculations regarding the differences in the surface flux with the additional surface information are also presented. This new model is of significant utility particularly for chemical deposition to vegetative surfaces, evapotranspirative analysis in regional watershed, as well as for pest management.
MODELING AMMONIA EMISSION FROM SWINE ANAEROBIC LAGOONS

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Abstract

Ammonia emission from anaerobic swine lagoons is an important issue regarding potential air pollution and potential deposition of N at other locations. A model is needed that can predict ammonia emission using basic parameters that can be easily measured. This paper will summarize various models and methods that have been used for determining ammonia emission from lagoons, manure slurry storage pits or tanks, and flooded soils. Although turbulence and stability of the atmospheric boundary layer has influence on ammonia emission from lagoons, the objective of the paper is to evaluate whether a model using only four easily-measured parameters can be useful.

The model assumes that ammonia emission is influenced by four primary factors: the lagoon liquid's total ammonia concentration, pH, and temperature near the lagoon surface, and wind speed. The ammonia emission model is based on chemical and volatilization aspects. The chemical aspects of the model deal with the NH4+/NH3(aq) equilibrium in lagoon liquids. The dissociation reaction of ammonium ions into free ammonia is a first-order reaction. The transfer of NH3 across the liquid-air interface of lagoon systems is characterized by a first-order volatilization rate constant, which is based on the two-film theory, and estimated using equations from literature data that require wind speed and temperature. By combining the chemical dynamics of the NH4+/NH3(aq) system with transfer of gaseous NH3 across the interface, an equation was developed to determine the NH3 emission rate from swine lagoons as a function of the four primary factors. The interactive effects of the four factors can be studied by individually varying one factor while maintaining the other three factors at their mean values. It is seen that with the increase of factors such as pH, temperature, or wind speed, the NH3 desorption rate is increased appreciably.

The model results will also be compared to ammonia flux data from field experiments using two different methods to measure ammonia volatilization: (1) a floating chamber method used by Dr. Viney Aneja's research group at four or more swine lagoons with various total ammonia concentrations, and (2) a micrometeorological method used by Dr. Lowry Harper at three swine lagoons. Dr. Harper has developed a statistical regression model from his data using the same four parameters used in our model: liquid temperature, pH, and total ammonia concentration, and wind speed. Thus, sensitivity of Harper's regression model and our two-film model to changes in the four parameters can be evaluated.

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AN INTEGRATED DYNAMIC, PHYSIO-CHEMICAL APPROACH TO
ASSESSING THE TRANSPORT AND DEPOSITION OF CHEMICAL
SPECIES IN EASTERN NORTH CAROLINA.

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Abstract

There is an increasing interest regarding the fate of nitrogen compounds locally emitted in the southeastern United States. The problem is particularly complicated in agricultural portions of watersheds where the land boundary can function as both a significant sink and source for atmospheric nitrogen. A quantitative assessment of this boundary condition both from the context of the regional atmospheric nitrogen budget and with respect to the variability of local atmospheric nitrogen deposition would constitute a significant improvement in the region's the cycling of nitrogen within its watersheds.

For a preliminary assessment, we have selected the coastal plain of North Carolina. Surface meteorological observations from over 20 weather stations across North Carolina for three periods: July 2-7 1998, October 5 - 11 1998, and December 12 -19 1998, are being analyzed. The first analysis objective is to understand the diurnal and, possibly, seasonal features of the wind field over eastern North Carolina. This mesoscale information allows insights regarding the trends and deviations possible in the dynamic trajectories of locally emitted nitrogen compounds. Using a tracer model, trajectories related to these days are also analyzed assuming a unit source strength ground release first in the northeast and then southeast portion of the NC coastal plain. Using a Monte-Carlo approach, for a simple gaussian plume analysis, the ranges for surface concentrations are obtained to complement the trajectory data under different observed scenario.

Once the material is transported, its deposition depends on surface features, in addition to the atmospheric variables such as humidity and precipitation. To understand the deposition potential, a detailed planetary boundary layer (PBL) model with a non-local closure scheme is coupled with an ecologically intensive soil-vegetation-atmosphere-transfer (SVAT) scheme to calculate boundary layer and canopy resistance. These resistances are used to determine the deposition velocity and the range of potential deposition flux for land types in eastern North Carolina.
Session VI
CONTROLLING ATMOSPHERIC EMISSIONS FROM ANIMAL WASTE TREATMENT: CHALLENGES AND OPPORTUNITIES.

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Abstract

Based upon EPA and USDA estimates, from two-thirds to more than 90% of the nitrogen in hog waste is volatilized as ammonia when the waste is treated in anaerobic lagoons and land applied via high pressure spray application. Current research efforts are ongoing to provide a better estimate for the systems and climate in North Carolina. Notwithstanding the anticipated revisions as a result of this research, there is no doubt that modifications of the current waste treatment technology to contain the atmospheric loss of nitrogen will either increase the amount of land required for waste treatment, if all the animal waste is to be land applied, or require reductions in herd size. Currently available information would indicate that from 3 to 10 times as much land could be required to grow sufficient crops to utilize all the nitrogen in animal waste if none where lost to the atmosphere.

On the other hand, the increased nitrogen concentration in the waste would improve the nutrient balance with phosphorus making a better fertilizer. The capture of nitrogen increases the value of the waste, allowing more economic recovery for the grower if the right market can be found. Odor control and energy production from methane are additional benefits which could be realized by techniques which reduce nitrogen volatilization. Realization of additional economic streams inherent in the manure could benefit both the grower and the local community in which he or she lives, as well as the environment. Strategies to transition from current waste treatment technologies to resource recovery technologies will be discussed.
ASSESSING THE FLUX AND BIOAVAILABILITY OF ATMOSPHERIC ORGANIC NITROGEN TO NORTH CAROLINA COASTAL ECOSYSTEMS.

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Abstract

Atmospheric organic nitrogen (AON) has recently gained attention as an additional and quantitatively significant, yet rarely assessed, source of atmospheric N loading to coastal and estuarine ecosystems. Little is known about its importance as a nutrient source for algal primary producers or its potential role in the eutrophication of marine systems. The flux and potential bioavailability of AON in coastal North Carolina (Bogue Sound) were evaluated using event-based collections and enrichment bioassays with natural algal communities. Mean dissolved organic N (DON) concentration for two years of rainwater samples analyzed using a high-temperature oxidation technique was from 2 to 4 μM, or approximately 10-20% of total N concentration. Annual DON deposition (wet only) was 10% of total N deposition and was greatest for season and storm types with the most rainfall. Enrichment of coastal water with isolated rainwater DON produced increased phytoplankton biomass and carbon fixation, but not as large as the response to inorganic N additions. Bioassays suggest that a portion of the AON pool is available to primary producers on short (hours to days) time scales. The impact of AON on marine ecosystems over longer time scales and at natural loading rates requires further investigation.
GROUNDWATER CONTAMINATION OF PRIVATE DRINKING WELL WATER BY NITRATES IN HOMES ADJACENT TO INTENSIVE LIVESTOCK OPERATIONS (ILO)

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Abstract

Since October 1995, OEES has conducted a program established by the governor of North Carolina that samples for free any private well in the state adjacent to an ILO for nitrate contamination. As of August, 1998, 1,595 wells in 57 counties have been tested. 34.2% of the wells (546 out of 1,595) have exhibited nitrate contamination above 2ppm. 10.2% of the wells (163 out of 1,595) have exhibited nitrate contamination at/or above the drinking water standard of 10ppm and may pose an increased health risk upon consumption. Hog farms in several counties have been identified as the responsible party in the contamination of some offsite private wells. Hog lagoons and wastewater spray fields have been responsible for well contamination in these instances. The poor condition of private wells, especially in eastern North Carolina has exacerbated the nitrate contamination of many of the wells tested in this program.
Poster Presentations
COUPLED TRANSPORT AND CHEMICAL REACTION MODEL
FOR AMMONIA EMISSION AT WASTE TREATMENT LAGOON-
ATMOSPHERIC INTERFACE

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Abstract

Global emission of ammonia is approximately 75 Tg N/yr. The major source is excreta from domestic animals (~32 Tg N/yr). Waste treatment lagoons are used to treat the excreta of hogs in North Carolina. Proteins and nitrogen rich compounds in the lagoon are converted to ammonia, through a series of biological and chemical transformation in anaerobic conditions. This ammonia is volatilized into the atmosphere. To investigate the process of ammonia emission, a coupled transport and chemical reaction model of ammonia across lagoon-atmospheric interface is developed. Analysis of flux is performed with two film model of transport. The equilibrium ammonia flux is determined with an empirical mass transfer approach. A sensitivity analysis is performed on the model. The model is validated using data collected from swine waste treatment facilities in NC.
ENVIRONMENTAL INFLUENCES ON NITRIFICATION IN SPRAY FIELDS FERTILIZED WITH LIQUID SWINE EFNUENT

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Abstract

Microbial nitrification is an energy-yielding activity whereby NH$_4^+$-N is oxidized to NO$_3^-$-N by specialized chemoautotrophs. Nitrification provides substrate (NO$_3^-$-N) for coupled nitrification-denitrification, whereby NO$_3^-$-N is reduced by denitrifying microorganisms to N$_2$ and N$_2$O and lost from the ecosystem. The effects of temperature, moisture, dose and field type on the response of nitrifying bacteria was studied in intact soil cores (0 to 20 cm) amended with liquid lagoon effluent. In most cases, complete nitrification of added effluent (2.4 to 10 g NH$_4^+$-N) occurred within 10d from a field regularly irrigated with lagoon effluent, but not in soils from a fallow field. Nitrifying activity was localized in the 0 to 5 cm zone where most of the added effluent resided. The increase in NO$_3^-$-N over the experimental time course accounted for roughly 80% of the total effluent-N added. Microbial immobilization did not decrease the accumulated NO$_3^-$-N pool, pointing to the importance of crop utilization or denitrification to prevent off-site transport. The time-linear increase in NO$_3^-$-N accumulation was used to calculate nitrification rates. Temperature, dose and field type (spray history) significantly influenced nitrification rates, while moisture level had no effect. Effluent -N is predominately NH$_4^+$-N (~90%) and therefore has little mineralization capacity. However, short term immobilization and subsequent remineralization of effluent-N may be important in determining the long-term availability of NO$_3^-$-N.
COMPARISON OF EMISSIONS OF NITROGEN AND SULFUR OXIDES TO DEPOSITION OF NITRATE AND SULFATE BY STATE IN 1990

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Abstract

Many naturally occurring and human-induced activities result in the emission of nitrogen- and sulfur-containing compounds into the atmosphere. Precipitation is an important process by which compounds are scavenged from the atmosphere and deposited onto the earth's surface. The purpose of this paper is to compare the emissions of nitrogen oxides (NOx) and sulfur dioxide (SO2) in each of the 48 contiguous states in the USA with measured wet deposition of nitrate (NO3-) and sulfate (SO42-) in each state for the year 1990. With one exception (Vermont), wet deposition of N as nitrate was less than emissions of N as nitrogen oxides on a statewide basis in 1990. The median wet N deposition/emission value was 0.21. Wet plus dry N deposition of nitrate was estimated to represent 43% of NOx emission in North Carolina. Wet deposition of S was less than emissions in 1990 in all but five states (Vermont, Maine, Arkansas, Nebraska, and South Dakota). The median value of wet deposition of sulfate/SO2 emission was 0.34. In North Carolina, dry deposition of sulfate was estimated to represent an additional 21% of emissions, so that total deposition accounted for 60% of S emissions. Net transport of N and S is likely an important part of the discrepancy between emissions and deposition.
TRANSPORT AND FATE OF NITRIC OXIDE IN THE CLAY FRACTION OF NATURAL AND ENGINEERED SOIL SYSTEMS

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Abstract

The transport and fate of nitric oxide (NO) in the clay fraction of natural and engineered soil systems is studied in laboratory experiments and analyzed using sorption isotherm models. Nitrogen oxide emissions from soil result in the loss of valuable nitrogen as the nitrogen becomes unavailable to natural soil ecosystems and unavailable to engineered agricultural production and waste recycling systems. These nitrogen releases further can impact public health and crop production by catalyzing the formation of troublesome ozone (O₃). Consequently NO is studied here to gain a better understanding of its transport and fate in the clay fraction of natural and engineered soil systems.

Newly developed laboratory equipment and procedures are presented and discussed, and the results of experiments designed to monitor the transport, transformation and deposition of NO in soil are summarized. Selected sorption isotherm models are developed and applied to the laboratory results. These models are suggested to be useful methods for analyzing NO movement and deposition in natural and engineered soil systems. Methods to control the loss of nitrogen from the soil to the atmosphere are considered.
EVALUATION OF AVAILABLE CONTROL MEASURES, POTENTIAL EMISSION REDUCTIONS, AND COSTS OF CONTROL FOR ANTHROPOGENIC EMISSIONS OF NITROUS OXIDE

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Abstract

A number of emission control cost models have been developed for greenhouse gases. To date, these models have focused primarily on carbon dioxide (CO₂) emissions. The purpose of this effort was to develop cost and emission reduction information that will allow the incorporation of nitrous oxide (N₂O) control measures into overall global warming control models. N₂O is a greenhouse gas with an estimated global impact about 310 times that of carbon dioxide, for which concentrations have been increasing in the atmosphere. Anthropogenic sources of N₂O include the decomposition of waste from domesticated animals, the decomposition of nitrogen-based fertilizers, some combustion processes, and some industrial processes such as adipic acid and nitric acid manufacture. The present study identified a wide array of control measures for anthropogenic emissions of N₂O. Costs and potential emission reductions were calculated for measures with cost-effectiveness values of less than $200 per ton of carbon equivalent. Cost calculations indicated that some control of N₂O emissions would be achievable at a net cost savings.
FRACTIONAL PORTION OF CROP NUTRIENT REQUIREMENTS
PROVIDED BY PRECIPITATION IN NORTH CAROLINA:
TOBACCO AND LOBLOLLY PINE

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Abstract

Nitrogen and sulfur (and 14 other) essential nutrients are obtained by plants from both soil and atmospheric sources. This study using flue-cured tobacco and loblolly pine is the first assessment of the fractional part of nutrient requirements of North Carolina crops and forests being met from the atmosphere. Concentrations of SO42--S and both NO3--N and NH4+-N and precipitation amounts in 1992 were obtained from National Atmospheric Deposition Program/National Trends Network, in addition to precipitation amounts from the National Weather Service. Preliminary estimates of N and S dry deposition were made using data from three Clean Air Status and Trends Network sites in NC. County-level calculations show that: a) precipitation provided 55-122% (mean 77%) of the S needed by the tobacco crop; b) dry deposition of gases and aerosols provided 18-41% (mean 26%); and thus c) total (wet+dry) deposition provided about 73-163% (mean 102%) of the S required by tobacco in NC counties. Similar calculations for atmospheric inputs of N showed: a) 5-10% (mean 7%) from precipitation; b) 4-7% (mean 5%) from dry deposition; and thus c) total (wet+dry) deposition provided about 9-17% (mean 12%) of the N required by tobacco. These estimates should be considered ipotential (upper-bound) estimates of tobacco nutrient needs being met by contemporary atmospheric sources. For loblolly pine, more than 100% (mean 159%) of sulfur requirements were met by wet deposition in 1992 in each NC county. Precipitation provided 5-9% (mean 6%) of N required by loblolly, while total (wet+dry) deposition was estimated to provide 9-16% (mean 11%).
ASSESSING THE FATE AND TRANSPORT OF ATMOSPHERIC NITROGEN AND VOCs IN NORTH CAROLINA: POTENTIALS OF THE NC ECO NET

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Abstract

One of the principal requirements in developing a realistic scenario regarding the transport and fate of nitrogen and other VOCs in North Carolina, has been the availability of accurate, continuous, representative, and easily accessible meteorological observations. Towards such a requirement, we present the concept and steps underway in developing the North Carolina Environment and Climate Observation Network (NC-ECO Net). The NC-ECO Net in its final phase will comprise of at least 100 automated weather stations (one per county) providing near real time agro-meteorological data for diverse applications such as dispersion and diffusion of nitrogen and other air pollutants and watershed management related issues in North Carolina. Significant technological and management related challenges need to be addressed. First, integration of different networks (Climate Offices Ag Network; Forestry; NWS / FAA ASOS, AWOS, and others). The challenges in this integration are hardware related (instrumentation compatibility, data formats, communication protocols,..), and application related (data averaging time, data format, agency requirements). An inherent challenge in this is the communication cost using the traditional phone and modem based technology, as against satellite transmission for internet based data access which can link all the schools, community colleges, and different statewide agencies. The synergism in this combined approach of integrating all the measurement platforms, and developing the back and front-end protocol, and an effective dissemination system, will be extremely useful for environmental assessment, education, and natural resource management in North Carolina.
COMPARISON OF NITROGEN EMISSIONS AND DEPOSITION IN NORTH CAROLINA AND THE NETHERLANDS; SUGGESTIONS FOR A CONCEPT OF OPTIMUM NITROGEN MANAGEMENT FOR SOCIETY

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Abstract

So far, the processes of enhancing agricultural and forest production and making pollution-control adjustments in the industrial, commercial, agricultural, and transportation systems of society have proceeded in more or less complete isolation from concern about the environmental consequences of human alterations in the nitrogen cycle of the earth. Also, so far, most pollution abatement and mitigation strategies have been aimed at resolving one or another particular societal pollution problem in which oxidized and reduced forms of nitrogen play a part. The time has come to consider alternative, more fully integrated strategies and tactics by which to optimize societal efforts to maintain or increase agricultural and forest production while also enhancing the effectiveness and decreasing the cost of abating or mitigating various nitrogen-induced aspects of soil-, air-, and water pollution.

To explore these ideas more fully, we: (1) describe some important similarities and differences in nitrogen emissions and deposition and their probable impacts on agriculture, forestry, and surface and ground water quality in the Netherlands and North Carolina; (2) consider these similarities and differences in light of the theory of optimum nutrition developed by Torsten Ingestad in Sweden and adapted to ecosystem productivity by Per Gunderson in Denmark; (3) provide justification for adopting a total fixed nitrogen approach rather than continuing to deal with oxidized and reduced forms of nitrogen separately; (4) propose a concept of optimum nitrogen management for society; and (5) discuss these concepts in the context of the Multiple Pollutant/Multiple Effects Protocol soon-to-be-adopted by the United Nations Economic Commission for Europe (UN-ECE).

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000407
DAIRIES AND THEIR RELATIONSHIP TO WATER QUALITY PROBLEMS IN THE CHINO BASIN

Region 8

California Regional Water Quality Control Board
Santa Ana Region

July, 1990
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SANTA ANA REGION

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Special thanks to other Regional Board staff for their help in putting together the final manuscript.
There is growing awareness of and concern about the severe salt imbalance problem now evident in the groundwaters of the Chino Basin. Excess salts (including nitrates) adversely affect the beneficial uses of these waters for municipal, agricultural and industrial supply. The movement of this poor-quality groundwater into the Santa Ana River significantly impacts the quality of this surface water body as well. Since the River flows are used to recharge the Orange County drinking water aquifer, the salts contained in Chino Basin groundwaters ultimately affect the quality of water served to Orange County residents. Modeling studies confirm that this salt imbalance problem will increase significantly over time unless appropriate control and/or cleanup measures are successfully implemented.

While there are a number of contributors to this problem, including irrigated agriculture and municipal wastewater discharges, it is clear that dairy operations in the Chino Basin are of overwhelming importance. The Chino Basin contains the highest concentration of dairies found anywhere in the world. The large animal population generates considerable volumes of liquid and solid waste, which contain significant quantities of salts. The Santa Ana Regional Board initiated a regulatory program to address the water quality impacts of the salt loads from dairy operations in 1972. This program has not changed significantly since that time. The severity of the water quality problem now confronting the Region in the Chino Basin demands reconsideration of the Board's dairy regulatory strategy, both in its design and in its implementation.

Accordingly, the Regional Board directed staff to prepare a report which would both describe the present dairy regulatory program and review, in detail, the rationale for the specific strategies employed. This report was prepared in response to that direction.

This report includes a summary of the water quality problems in the Chino Basin, a discussion of possible sources, and a detailed analysis and discussion of the theoretical basis for the Board's dairy regulatory strategies. Finally, the report contains a proposed dairy strategy based on this detailed analysis. The level of detail apparent in the report, and the intensity of staff effort needed to produce it, reflect the severity of the concern about the impacts of dairy operations on water quality, both within and downstream of the Chino Basin.
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I: PROBLEM DESCRIPTION

A. Introduction

As in most of Southern California, the Santa Ana Region is highly dependent on groundwater to meet the needs of an increasing population. The Chino Groundwater Basin is the largest basin in the Santa Ana Region. It is divided into three subbasins, Chino I, Chino II and Chino III (Figure I-1). The Basin covers about 245 square miles and contains about 43 million acre feet (acre-ft) of water, 9.4 million acre-ft of which is producible. The Chino Basin is adjudicated, with the safe yield determined to be 140,000 acre-ft/year. Water extracted from the Basin is divided among three pools, the agricultural pool (primarily dairies), non-agricultural pool (industrial) and appropriative pool (municipal).

The Basin is affected by a long-term adverse salt balance, i.e., more salt enters the Basin than is exported from it. As a result, the total dissolved solids and nitrate quality of the groundwater in the Chino Basin has been deteriorating for many years and is projected to continue to deteriorate.

The groundwater quality of the Chino Basin is of the utmost concern for several reasons. First, groundwater within the Chino Basin is used extensively for municipal, industrial and agricultural supply.
Second, poor quality groundwater (and salts present in unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of a Groundwater Storage Program (Storage Program) proposed by the Metropolitan Water District of Southern California (MWD). Under this Storage Program, 300,000 to 700,000 acre-ft of high quality water from the State Water Project would be stored in the Chino Basin for use in emergency and drought conditions when imported water is either limited or not available. Such a program would be highly advantageous to water purveyors within the Region.

The third major concern is that poor groundwater quality in the Chino Basin adversely affects the quality of water in the Santa Ana River (River) and, ultimately, the quality of water supplied to Orange County residents. A brief explanation of this problem is warranted:

At the southern end of the Chino Basin, approximately 10,000 acre-ft/year of rising groundwater surfaces and enters the River just upstream of Prado Dam. It is estimated that this rising groundwater accounts for 5 to 10 percent of the River base flow, and it has the worst quality of any single input into the River (municipal sewage treatment plant effluents discharged to the River constitute 90 percent or more of the base flow, but are of better quality with respect to TDS and nitrate than rising groundwater). Recent findings from the watershed-wide nitrogen study (see discussion below) indicate that rising groundwater accounts for approximately
30% to 40% of the nitrate measured at Prado and about 50% of the TDS. As the quality of groundwater within the Chino Basin deteriorates, the quality of rising groundwater that enters the River will also continue to degrade. The River flows through Prado Dam and into Orange County, where it is captured by the Orange County Water District for recharge of the Orange County groundwater basin. The River flows constitute approximately 60 percent of the recharge to this basin, which is the primary source of drinking water in Orange County. Thus, poor quality groundwater in the Basin will ultimately have a significant impact on the quality of drinking water in Orange County.

The Regional Water Quality Control Board - Santa Ana Region (Board) and other agencies and parties have made intensive efforts to protect and enhance the quality of the River and, thereby, to protect the downstream municipal supply beneficial uses. The Board has established water quality objectives for TDS and nitrogen (and other constituents) for the River at Prado Dam. To ensure that these objectives are met, the Board has adopted wasteload allocations for both of these parameters. Each point source discharger to the River (i.e. sewage treatment plants) has been allocated a portion of the total nitrogen and TDS wasteloads to the River. These allocations are implemented through effluent limitations in discharge permits issued by the Board (nonpoint sources such as rising groundwater, are also taken into account in the allocation
process). This regulatory program has contributed to an overall improvement in the TDS concentration in the River over time. However, monitoring data collected the last several years indicates the water quality objective for nitrogen (10 mg/l total nitrogen (filtered sample)) is now being exceeded. In response to these findings, a $1,000,000 watershed-wide nitrogen study is now in progress under the auspices of the Santa Ana Watershed Project Authority, Santa Ana River Dischargers Association, the Board, MWD and other local agencies. A primary objective of this study is to recommend measures which should be employed to ensure that the nitrogen objective for the River is met. This is likely to include a recommendation for a revised nitrogen wasteload allocation. The effectiveness of any measures which are implemented at sewage treatment plants may well be compromised by inputs of increasingly poor quality groundwater rising into the River from the Basin, unless corrective actions are taken.

B. Groundwater Quality Problems in the Chino Basin

A recent comprehensive evaluation of the quality of groundwater in the Chino Basin was performed by MWD in 1986 as part of an environmental impact report for MWD's proposed Storage Program. Through the initial feasibility study, Interim Environmental Study and Notice of Preparation process, several concerns regarding the proposed Storage Program were identified. These concerns included
groundwater level changes in the Basin and groundwater quality changes in the Basin and the Santa Ana River. As a result, MWD examined historical water quality in the Basin and conducted an extensive sampling program. The data obtained were used in modeling efforts in which the water quality impacts associated with two alternative operational scenarios for the Storage Program were examined. An evaluation of the water quality impacts that would occur in the Chino Basin and the River without the Storage Program was also conducted as a third scenario. The Regional Board's groundwater quality and quantity models (known collectively as the Basin Planning Procedure or BPP) were used for these evaluations. Historically, the BPP has been calibrated only to examine TDS quality impacts. However, for MWD's work, modifications to the BPP were made so that water quality impacts with respect to nitrate could be investigated as well.

MWD found that groundwater quality becomes progressively worse as the groundwater moves south toward the River. Water recharging the groundwater in the Chino I subbasin, in the northern area of the Basin, has a TDS concentration of about 180-200 mg/l, and a nitrate concentration of about 2 mg/l. TDS and nitrate concentrations increase steadily in the direction of the River, reaching 1000+ mg/l of TDS and 200+ mg/l of nitrate in portions of Chino III (1986 data). MWD concluded that the distribution of TDS and nitrate concentrations in the Basin is consistent with waste water discharges associated with historical land uses, and that the
increase in TDS and nitrate concentrations are the result of discharges of agricultural and municipal wastewater.

MWD's evaluation of historic TDS and nitrate quality in the Chino Basin confirmed previous findings that TDS and nitrate concentrations have been increasing in the Basin. Their review of the TDS and nitrate concentrations in the Chino Basin since 1950 indicates an interesting but alarming trend.

In 1950, groundwater in Chino I had a TDS concentration of generally less than 200 mg/l, Chino II about 200-300+ mg/l and Chino III about 300-500+ mg/l (Figure I-2). By 1986, groundwater quality had significantly worsened (Figure I-3). MWD determined that TDS concentrations in pumped groundwater in 1986 were 240 mg/l in Chino I, 333 mg/l in Chino II and 709 mg/l in Chino III. MWD also projected the future TDS and nitrate quality of the Chino Basin using baseline conditions without the Storage Program. The MWD runs for TDS for the year 2000 showed that while the TDS quality of Chino I and Chino II did not significantly change, the TDS quality of pumped water from Chino III rose to 753 mg/l. Projections for the year 2045 showed that the TDS quality in pumped water from the Chino Basin rose to 249 mg/l in Chino I, 408 mg/l in Chino II, and 995 mg/l in Chino III. TDS concentrations in portions of Chino II were shown to be as high as 1000 mg/l, and in Chino III as high as 1600 mg/l (Figure I-4). This information is summarized in Table I-1.
The same water quality trend between 1950 and 2045 is even more evident for nitrate. In 1950, the entire Basin exhibited nitrate concentrations less than 20 mg/l, with much of the Basin less than 10 mg/l. An exception was a small area of groundwater in the southern-central area of Chino II which was about 50 mg/l, exceeding the drinking water standard of 45 mg/l (Figure I-5). Between 1950 and 1986, nitrate concentrations steadily increased, and the area exceeding 45 mg/l gradually enlarged. As with TDS, sampling in 1986 showed dramatic increases in nitrate concentrations, especially in the southern part of Chino II and the northern part of Chino III (Figure I-6). Not surprisingly, these groundwater areas underlie or are down gradient from the dairy area. MWD determined that the average nitrate concentration in pumped groundwater from the Basin in 1986 was 23 mg/l in Chino I, 40 mg/l in Chino II, and 63 mg/l in Chino III. Projections for the year 2000 did not show a significant change in nitrate concentrations in Chino I, but nitrate concentrations in Chino II rose to 49 mg/l and to 98 mg/l in Chino III. Projections for the year 2045 showed that nitrate concentrations in pumped groundwater were 25 mg/l in Chino I, 85 mg/l in Chino II, and 211 mg/l in Chino III. Almost the entire southern half of the Basin was found to exceed the drinking water standard of 45 mg/l (Figure I-7). This information is summarized in Table I-2.
### TABLE I-1

**Pumped TDS Concentration Projections by Subbasin (mg/L)**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>1950</th>
<th>1986</th>
<th>2000&lt;sup&gt;1&lt;/sup&gt;</th>
<th>2045&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>200</td>
<td>240</td>
<td>239</td>
<td>249</td>
</tr>
<tr>
<td>Chino II</td>
<td>200-300</td>
<td>333</td>
<td>343</td>
<td>408</td>
</tr>
<tr>
<td>Chino III</td>
<td>300-500</td>
<td>709</td>
<td>753</td>
<td>995</td>
</tr>
</tbody>
</table>

1. Model results without the Storage Program.

**SOURCE:** MWD Chino Basin Groundwater Storage Program EIR (1987)

### TABLE I-2

**Pumped Nitrate Concentrations Projections by Subbasin (mg/L)**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>1950</th>
<th>1986</th>
<th>2000&lt;sup&gt;2&lt;/sup&gt;</th>
<th>2045&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>10</td>
<td>23</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Chino II</td>
<td>15</td>
<td>40</td>
<td>49</td>
<td>85</td>
</tr>
<tr>
<td>Chino III</td>
<td>15</td>
<td>63</td>
<td>98</td>
<td>211</td>
</tr>
</tbody>
</table>

2. Model results without the Storage Program.

**SOURCE:** MWD Chino Basin Groundwater Storage Program EIR (1987)
FIGURE 1-2

YEAR 1850
TOTAL DISSOLVED SOLIDS
CONCENTRATION IN PUMPED
GROUNDWATER

SOURCE: MD CHINO BASIN GROUNDWATER
STORAGE PROGRAM EIA (1987)

LEGEND

-600 CONTOUR OF EQUAL
CONCENTRATION (mg/L)
SOURCE: NRE, 1970
FIGURE 1-6

YEAR 1986
NITRATE CONCENTRATION IN PUMPED GROUNDWATER


LEGEND

• CONTOUR OF EQUAL
  CONCENTRATION (mg/L)
  NITRATE CONCENTRATION
  EXCEEDING DRINKING WATER
  STANDARD OF 45 mg/L.
These model evaluations provide valuable information with respect to surface water quality in the Santa Ana River as well as groundwater quality in the Chino Basin. The model runs indicate that the nitrogen concentrations in the Santa Ana River will increase from 9 mg/l (1985) to about 22 mg/l of nitrogen (NO₃-N) (99 mg/l as nitrate) by the year 2000, far exceeding the water quality objective for total nitrogen of 10 mg/l. Poor quality groundwater rising into the River from the Chino Basin is a significant contributor to this problem; as noted earlier, recent sampling in the River (1988) as part of the watershed-wide nitrogen study showed that rising groundwater accounted for about 30% to 40% of the nitrate measured at Prado.

The findings of other BPP work which has been conducted over the years are consistent with MWD's results. Model runs executed in conjunction with the development and update of the 1975 and 1983 Basin Plans projected continued deterioration of groundwater quality in the Chino Basin over time. The Regional Board and SANPA are currently coming to the end of a three year Basin Plan update study (1987-1990). A baseline BPP run was performed at the outset of the study (a baseline run is an extension into the future of present water/wastewater management conditions; the results of this run form the basis for developing and evaluating alternative water and wastewater management strategies); the results again project water quality degradation in the Chino Basin. The baseline run
shows that TDS quality in the Chino II groundwater subbasin will increase from 347 mg/l to 387 mg/l by the year 2015, about a 12% increase (Figure I-8). TDS in the Chino III subbasin is projected to increase from about 700 mg/l to 915 mg/l (31% increase) (Figure I-9). Alternative strategies to address this problem have been evaluated in the course of both prior and current Basin Plan update work. The results of some of these alternative analyses will be described later in this section.

It should be noted that the Chino Basin Watermaster has recently completed the first year's sampling of a comprehensive monitoring network which includes 198 wells. Of these 198 wells, 67 were selected primarily to cover the agricultural area south of the Pomona Freeway. The data obtained from this sampling effort support the BPP projections. The data show high nitrate and TDS concentrations in shallow wells in many areas of the Basin. Some deep wells also show elevated nitrate and TDS concentrations. This poor quality groundwater (and additional salts now in transient in the unsaturated zone) will, sooner or later, adversely affect the groundwater basin as a whole, as indicated by the BPP.

Before moving to a discussion of the possible sources of this severe water quality problem, a final note with respect to the BPP work conducted to date is appropriate. As was stated previously, historically, the BPP was calibrated only for TDS; Basin Plan update model work through 1988 focused solely on TDS water quality.
projections. To explore the various potential water quality impacts of implementation of their proposed Storage Program, MWD had modifications made to the BPP such that nitrate impacts in the Chino Basin specifically could be examined as well. More recently, the BPP was actually calibrated for nitrate (and TDS) so that impacts can be explored throughout the Upper Santa Ana and San Jacinto Basins. This work was conducted as part of the watershed-wide nitrogen study. The revised BPP provides more reliable projections of nitrate quality than MWD's work (since the BPP was calibrated for nitrogen) and will substantially enhance the Region's planning capabilities.
C. Sources of Groundwater Degradation in the Basin

As noted earlier, the sources of groundwater degradation in the Basin include agricultural and municipal waste waters; the areas exhibiting the worst degradation reflect these historical land uses. But while irrigated agriculture and municipal wastewater disposal are certainly contributors to the degradation, it is evident that dairy wastes play an overwhelmingly significant role in waste loads discharged to the Basin. As early as the 1970's, it was well recognized that the application of dairy manure and dairy washwater was threatening underlying groundwater quality (Adriano et al., 1971; Pratt et al., 1972; Pratt et al., 1976a; Pratt et al., 1976b). These studies documented high concentrations of nitrate and salt within the soil profile underneath dairies within the Basin dairy area (Adriano et al., 1971; Chang et al., 1973).

The relative significance of dairies as contributors to the groundwater quality problem is evident if one compares the salt loads which result from these operations to those from other types of land use. These comparisons can be made using data from the BPP. A detailed discussion of the BPP is not possible or appropriate here. Suffice it to say that a critical first step in the model operations is the calculation of the salt waste loads which result from various land uses. The model performs these calculations by multiplying land use acreages in various categories
(e.g., dairies, irrigated agriculture, etc.) by salt loading factors (unit factors) which are specific to each type of land use. (A more detailed discussion of this computational step is provided in Appendix A). These salt load data are then entered into the quality model portion of the BPP and projections of ground (and surface) water quality can be made over time.

Staff took two comparative approaches, both using BPP salt input data, to investigate the relative significance of dairies as salt contributors. One analysis was conducted using data from the 1983 Basin Plan update BPP runs. For the second analysis, data from the most recent calibration of the BPP was utilized. Each of these analyses is discussed below.

In the first approach, staff analyzed BPP data used in the 1983 Basin Plan update BPP runs. The salt loads to groundwater which were calculated for the year 1990 for the Chino Basin dairy area (which included about 19,300 acres of agricultural land and about 1,900 acres of residential-commercial-industrial land') are shown in Table I-3. Note that agricultural land use accounts for about 97% of the salt load added to groundwater.

---

'The 1983 model runs show the Chino dairy area to be contained in two Water Supply Agency areas (these are artificial agencies used for modeling purposes). These agencies are No. 371 (called the "West of Corona City") and No. 381 ("South of Ontario"). The "agency" boundaries are depicted in Appendix C.
To determine the amount of salt added to the groundwater by dairy operations in the Chino dairy area relative to other agricultural land uses, staff made changes to the model input and portions of the model were rerun. Specifically, the dairy salt unit factor was set to zero (from 2.4 tons salt/acre/year), while the other unit factors were left unchanged. The results show that about 88% of the agricultural salt load within the dairy area is due to dairy operations (Table I-4).

Under the second approach, staff analyzed data on historical salt contributions to the Chino Basin by various types of land use, including dairy operations. Data used in the recent BFP calibration indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 are presented in Table I-5. This data represents salts that are added to water as a result of use and that will reach groundwater. Salt additions as a result of consumptive use (concentration of salts as a result of evaporation and/or transpiration) are not included. Note that this table includes data for land uses in the Chino I, II and III groundwater subbasins), as well as land uses in the Cucamonga subbasin area (this area is much larger than that considered in the first analysis described above (the Chino Basin dairy area)).
TABLE I-3

Salts Added to the Ground Water for Projected Year 1990

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Wastewater Returns AF/Y</th>
<th>Salt Added Tons/Year</th>
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<tr>
<td>Residential/Commercial</td>
<td>778</td>
<td>697</td>
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<tr>
<td>Agricultural</td>
<td>20,013</td>
<td>22,725</td>
</tr>
<tr>
<td>Industrial</td>
<td>43</td>
<td>17</td>
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<td></td>
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<td>23,439</td>
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TABLE I-4

AGRICULTURAL WASTE LOADS

Salt Added to Groundwater (Tons/Acre/Year) for year 1990:

Total Dissolved Solids (mg/l) for year 1990:

<table>
<thead>
<tr>
<th>Original Waste Load</th>
<th>Revised Waste Load</th>
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<tr>
<td>Dairy Waste Load = 2.4 T/A/Y</td>
<td>Dairy Waste Load = 0.0 T/A/Y</td>
</tr>
<tr>
<td>22,725</td>
<td>2,756</td>
</tr>
</tbody>
</table>

Total agricultural wasteload with dairies: 22,725 T/A/Y
Total agricultural wasteload w/out dairies: 2,756 T/A/Y

% of total agricultural wasteload due to dairies:

\[
22,725 - 2,756 = 19,969
\]

\[
\frac{19,969}{22,725} \times 100 = 88\%
\]

\(^1\)Non dairy agricultural salt unit factors assumed for "dairy acreage".
<table>
<thead>
<tr>
<th></th>
<th>%1980</th>
<th>%1982</th>
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<table>
<thead>
<tr>
<th>Land Use</th>
<th>%1980 Salt Added (TDS)</th>
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<th>%1983 Salt Added (TDS)</th>
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<td>468.876</td>
<td>468.876</td>
<td>468.876</td>
</tr>
<tr>
<td>Non- Irrigated</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Irrigated</td>
<td>139.942</td>
<td>139.942</td>
<td>139.942</td>
<td>139.942</td>
</tr>
<tr>
<td>Cattle</td>
<td>54.714</td>
<td>54.714</td>
<td>54.714</td>
<td>54.714</td>
</tr>
<tr>
<td>Irrigated Field Crops</td>
<td>38.522</td>
<td>38.522</td>
<td>38.522</td>
<td>38.522</td>
</tr>
<tr>
<td>Non-Irrigated Field Crops</td>
<td>94.738</td>
<td>94.738</td>
<td>94.738</td>
<td>94.738</td>
</tr>
</tbody>
</table>
Table I-5 shows the tons of salt added to the Basin by each of nine (9) different land use types, and the percentage of the total salt load contributed by each of these uses. It can be seen that dairy land use (6) appears to account for 51% of the salt added to the Basin between 1958 - 1986. Adjusted data on salt load additions and the percentage contributions by each land use type are also shown in this Table. These adjustments are necessary because of a problem with the way dairy acreage is accounted for in the BPP. In the BPP, dairy acreage is considered to include only those areas occupied by dairy animals; the BPP does not accurately reflect the total acreage affected by dairy waste disposal practices (e.g. cropland). To account for this, the salt loads associated with non-irrigated field crop acreage (land use 1) and a portion (38%) of irrigated crop acreage (land use 2) where dairy wastes are presumed to be applied were added to the dairy (land use 6) figure (see footnote 3 on Table I-5). When the data are adjusted in this way dairy land use accounts for 60% of the total salt added to Chino Basin groundwater from 1958 to 1986. [Note that this percentage differs from the 88% figure previously presented for dairy salt contributions; this difference is due to size of the area considered in each analysis (Chino Basin versus only the Chino Basin dairy area).]

Another method of demonstrating the relative significance of dairy salt loads was also employed in the preparation of this report. A special BPP model run was performed for the Board by James M.
Montgomery Engineers, Inc., using the newly calibrated model. This run was conducted to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in the Basin and the land was used instead for other types of agriculture. This simulation was performed by assuming that the dairy land use in the model was replaced by irrigated agriculture. The model run was conducted for the period 1990-2015, and the results were compared to the so-called baseline run for the same period. The baseline run was conducted as part of the ongoing watershed-wide nitrogen study and assumes the present pattern of dairy land use.

The differences between the special model run, without the dairy waste load, and the baseline run at the end of the 25-year planning period (2015) are shown in Tables I-6 (a) and (b) and I-7 (a) and (b). Table I-6 (a) and (b) show the decrease in concentrations of TDS and nitrate, respectively, which result from the removal of

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To perform this simulation, the TDS and nitrate loading unit factors utilized in the model for dairy land use were replaced with the unit factors for irrigated field crops. (Irrigated field crop salt unit factors are lower than those for dairies). (Salt loading unit factors and their application in the BPP are described in detail in Section III and Appendix A).

To make water quality projections beyond the year 1990 based on this revised land use scenario, it was first necessary to establish the groundwater quality conditions (initial conditions) that would have existed in the Basin in 1990 had dairies never been in operation in the Basin. This was done by running the calibration model, which utilizes data for the period 1960-1986 (substantial dairy land use began in the Basin about 1958), with the same changes to the unit factors described in footnote 2, above.
the dairy operations. These concentration decreases apply to pumped water quality (or available water). The amount of available water in storage that is affected by the concentration decrease is shown in the tables. When the concentration data is considered together with the volume of water affected, it is evident that the dairies have a significant effect on the quality of groundwaters, particularly in the Chino II and III subbasins.

Tables I-7 (a) and (b) show the decrease in the mass of TDS and nitrates in the Chino Basin which result from the removal of dairy operations. The change in TDS and nitrate mass observed applies to the total water in storage (also shown in the tables). It is evident from this data also that dairy operations have a significant impact on Chino Basin water quality.
### TABLE I-6(a)

**Difference in Total Dissolved Solids Concentration Between Baseline and "Without-Dairy", Model Runs After 25 years of Simulation (Year 2015).**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Total Dissolved Solids Concentration Decrease (mg/L)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>2</td>
<td>3.8 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>32</td>
<td>4.6 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>45</td>
<td>1.3 million</td>
</tr>
</tbody>
</table>

### TABLE I-6(b)

**Difference in Nitrate Concentration Between Baseline and "Without-Dairy", Model Runs After 25 Years of Simulation (Year 2015).**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Nitrate Concentration Decrease (mg/l)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>2</td>
<td>3.8 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>8</td>
<td>4.6 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>12</td>
<td>1.3 million</td>
</tr>
</tbody>
</table>
**TABLE I-7(a)**


<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Total Dissolved Solids Mass Decrease (tons)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>30,069</td>
<td>20.7 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>382,976</td>
<td>18.8 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>193,195</td>
<td>3.2 million</td>
</tr>
</tbody>
</table>

**TABLE I-7(b)**


<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Nitrate Mass Decrease (mg/l)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>21,561</td>
<td>20.7 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>103,607</td>
<td>18.8 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>43,118</td>
<td>3.2 million</td>
</tr>
</tbody>
</table>

I-30
Table I-8 provides a summary of pertinent data with respect to the Chino Basin dairy area. It is generally accepted that dairies in the Chino Basin represent the largest concentration of dairies in the world. Data compiled from the 1988 Annual Reports submitted to the Board by the dairy operators show that, within an area of about 15,000 acres (Figure I-10), there are approximately 300 dairies in the Basin which contain about 289,600 animals. These animals produce about 460,000 tons (dry weight)/year of manure, of which about 246,578 tons appears to be discharged ultimately within the Chino Basin. (As will be discussed elsewhere in this report, there is no definitive information on the fate of most of the manure generated in the Chino Basin). The total manure generated in the Chino Basin correlates to 132,020 tons/year of salt per year, of which 14,720 tons is nitrogen (as N) (Webb, 1974). On the order of 70,768 tons of salt appear to remain in the Chino Basin each year, of which about 27,631 tons reaches groundwater (see Appendix B).
### TABLE I-8
CHINO BASIN DAIRY DATA SHEET

**NUMBER OF DAIRIES IN THE CHINO BASIN IS APPROXIMATELY 300**

**NUMBER OF ANIMALS IN THE CHINO BASIN DAIRY AREA**

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking Cows</td>
<td>166,900</td>
</tr>
<tr>
<td>Dry Cows</td>
<td>33,300</td>
</tr>
<tr>
<td>Heifers</td>
<td>39,400</td>
</tr>
<tr>
<td>Calves</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>289,600</strong></td>
</tr>
</tbody>
</table>

**MANURE DISTRIBUTION IN THE CHINO AREA 1988**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total corral manure production</td>
<td>460,000 Tons</td>
</tr>
<tr>
<td>Amount of manure reported spread on disposal land</td>
<td>11,100 Tons</td>
</tr>
<tr>
<td>Amount of manure stockpiled</td>
<td>16,500 Tons</td>
</tr>
<tr>
<td>Amount of manure spread on croplands associated with dairies</td>
<td>45,500 Tons</td>
</tr>
<tr>
<td>Amount of manure reported hauled away</td>
<td>387,200 Tons</td>
</tr>
<tr>
<td>Amount of manure received by composters</td>
<td>70,355 Tons</td>
</tr>
<tr>
<td>Amount of manure hauled by others</td>
<td>316,845 Tons</td>
</tr>
<tr>
<td>Amount of manure hauled out of the Chino Basin by others (assumed 1/2 of the above)</td>
<td>159,422 Tons</td>
</tr>
<tr>
<td>Amount of manure reported by composters to be hauled out of the Chino Basin</td>
<td>55,000 Tons</td>
</tr>
<tr>
<td>Amount of manure remaining within the Chino Basin</td>
<td>246,578 Tons</td>
</tr>
<tr>
<td>Resulting amount of Salt (TDS) being discharged within the Chino Basin</td>
<td>70,768 Tons</td>
</tr>
<tr>
<td>Amount of Salt (TDS) reaching Chino Basin ground water (applied over 15,000 acres) (see Appendix B)</td>
<td>27,631 Tons</td>
</tr>
</tbody>
</table>

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1. Data compiled from 1988 Dairy Annual Report

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D. BPP - Alternative Analysis

The results of all model simulations described earlier, whether from the Regional Board's Basin Planning efforts or through the work of other agencies such as MWD, indicate similar conclusions. Excessively large salt loads have been entering the ground as a result of waste discharges from dairies. These salt loads, with their high nitrate concentrations, appear to have impacted and certainly will continue to impact groundwater in the Chino Basin and, ultimately, surface water quality in the Santa Ana River. In order to prevent, or at least minimize, this water quality degradation, it is clear that measures must be considered to reduce the dairy waste loads (TDS and nitrate), as well as methods that could be employed to remove salts already present in the groundwater. Such alternatives were considered in the 1975 and 1983 Basin Plan update work. Alternatives are also being considered as part of the current Basin Plan review. The alternatives that are now being evaluated with the BPP include a reduction in the dairy salt waste load (which might be accomplished through additional manure removal and/or washwater removal (see Section III of this report)) and the removal of salts now in the groundwater through the operation of desalting facilities in the Chino II and Chino III subbasins. Unfortunately, these alternative runs include other assumed water/wastewater management strategies (e.g., increased reclamation in specific areas of Chino Basin) which complicate the interpretation of the model results. That is,
it is not possible to distinguish the water quality impacts of the measures described above from those of other components of the alternative run. Ideally, additional, more specific model runs will be conducted if resource constraints will allow it. Nonetheless, it is clear from the alternative analysis that has been conducted that, irrespective of any other measures which might be implemented to address water quality problems in the Chino Basin, the construction and operation of desalters will be absolutely essential. Perhaps the most significant effect of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. The Santa Ana Watershed Project Authority is already pursuing the implementation of these facilities. Experience with desalting operations elsewhere in the Region (the Arlington desalter) and recent desalter feasibility studies indicate that the cost of these desalters will be on the order of $320 - $690 for every ton of salt removed.

E. Other Considerations

Groundwater Quality Data:

There is another important consideration with respect to the BPP projections discussed above which warrants separate attention. This pertains to the water quality data used for input into the BPP.
The data on which the modeling projections are based were derived from available sampling results from a limited number of wells within the Chino Basin. Although this information is sufficient to conclude that significant degradation is occurring in the Chino Basin, a clearer understanding of the extent and nature of this degradation is needed for future planning and mitigation activities. Some of the best available information was obtained in 1986 when MWD sampled 148 wells in the Chino Basin. However, there are currently over 500 wells in the Chino Basin, and existing groundwater data is limited to only a portion of these wells with many years separating sampling events.

In recognition of the need to obtain data from more wells on a more frequent basis, several agencies are expending resources to obtain more reliable groundwater data in the Chino Basin. The Santa Ana Watershed Project Authority has contracted with a consultant to determine where data gaps exist in the Chino Basin; the Chino Basin Watermaster has expedited efforts to improve its sampling program, and MWD will be developing a monitoring program with local agencies in the event MWD proceeds with its proposed Storage Program.

Throughout the Santa Ana Region, the Regional Board requires waste dischargers to monitor the quality of their discharges and the quality of the receiving water body. However, this has not been the case with dairies, all of which are operating under waste
discharge requirements. In order to remedy this situation, Regional Board staff contacted the Milk Producers Council and the California Milk Producers in early 1989, and requested their assistance in developing a groundwater monitoring program for dairies within the Santa Ana Region. The Regional Board could amend waste discharge requirements to include a monitoring program for each dairy, resulting in the need for each dairy to sample existing wells or to install monitoring wells on their property to assess the impacts their waste discharges are having on the underlying groundwater. However, this may be more extensive than what is actually necessary, and Regional Board staff believed that a more limited, efficient, and less expensive program could be developed and implemented in the dairy area under the direction of the two major dairy organizations in the Chino Basin. Despite the apparent advantages of such a program, the Milk Producers Council has refused to participate in this endeavor. The California Milk Producers (CMP) board also declined to fund the monitoring work because members outside the Chino Basin did not want to pay for monitoring solely within the Basin. However, the CMP has actively worked with the engineering contractor who will be sampling wells within the dairy area to identify the wells which must be sampled within the Chino Basin to evaluate dairy impacts. CMP has also actively lobbied the Chino Basin Watermaster to sample the above-described wells. In addition, CMP has volunteered to provide previously unreleased groundwater quality data which were generated in the recent past.
The Watermaster completed its first sponsored Basin-wide monitoring program for the Chino Basin in April 1990. The monitoring program included the dairy area wells as well as a representative sample of wells throughout the Basin. It is anticipated that this program will be continued.

Additional discussion regarding the need for a comprehensive groundwater monitoring program is to be found later in this report.

**Surface Water Quality Problems:**

The preceding discussion of water quality problems in the Chino Basin focused primarily on groundwater, although the significant effects of rising groundwater on Santa Ana River quality was also described. Dairy operations can also affect surface waters within the Chino Basin, and the Santa Ana River in a more direct fashion. Runoff of dairy washwater or stormwater which have come into contact with manured areas adversely affects the quality of those surface waters.

As described later in this report (Section III), the Board has adopted requirements on dairy operators which are designed to prevent these impacts. These include requirements for the containment of all washwater and all storm water runoff from
manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Unfortunately, these containment controls are not always constructed or maintained properly by the dairy operators, and discharges of wastewater to local surface drains occur. This surface water drainage problem is exacerbated in some areas by the extensive urban development occurring upstream of the dairy area. The significant increase in impervious surfaces associated with this urban development causes the amount and velocity of storm water runoff entering parts of the dairy area to increase dramatically. This, in turn, significantly affects the integrity of the containment controls implemented by the dairy operators and, therefore, the dairy operators' ability to comply with their waste discharge requirements. A number of studies have been conducted to determine effective solutions to this problem. Specific recommendations for the control of surface water impacts from dairy operations, in part based on the results of these studies, are included in the dairy strategy which is proposed at the end of this report.
II. DAIRY REGULATION IN THE SANTA ANA REGION: A BRIEF BACKGROUND AND OVERVIEW

In the 1950's, the center of the dairy population in Southern California was in Los Angeles County. There was, for example, a concentration of dairies in Torrance. Short haul distances had led the dairymen to locate there initially, but urban crowding soon induced them to move elsewhere. Many of the dairies that left the Los Angeles metropolitan area relocated in the unincorporated communities of Dairyland and Dairy Valley in southeastern Los Angeles County and western Orange County. Most of Orange County was still largely undeveloped and agricultural in the late 1950's and early 1960's.

Orange County urbanized rapidly in the 1960's and '70's. Pressure on operating dairies from encroaching urban development takes several forms: odor and nuisance complaints increase; runoff from additional paved areas leads to greater drainage problems, and traffic becomes a problem. Increases in land value, however, tend to make the necessary relocation easier and more acceptable. In addition, each time a dairy facility is rebuilt, there is an opportunity to improve on the design and increase efficiency.

Several dairies stayed on in Orange County as long as they could, but by the late 1970's, they were essentially all gone. Some of
the dairies scattered, but a great many relocated in the Chino Valley, a very attractive location for a number of reasons. It was generally warm and dry, reasonably level for the most part, and had nice morning and evening breezes. Land was reasonably priced, since it was farther from the centers of urban pressure. The haul distance to the creameries was longer than it had been, of course, but Chino was still a very acceptable compromise.

Historically, dairy corral design called for a slope away from the milk barn, usually toward the nearest stream or ditch. That way, when it rained in the winter, the milk barn stayed dry and excess manure was washed out of the corrals and off the property. From the point of view of the dairyman, there was no manure management problem with that arrangement. A number of the dairies established in the Chino area were built that way.

The very wet winter of 1968-69 made it clear that the dairies could not be allowed to continue to use local surface waters to dispose of their manure. When the storms ended and the water behind Prado Dam receded, the sight and smell of a great many tons of dairy manure were both obvious and overwhelming. This was one of the influences that motivated the Regional Board staff to begin thinking of ways to control the impacts of the dairies.

In 1972, the first sets of waste discharge requirements for the dairies were adopted by the Regional Board. It was felt that the
first, easiest and most reasonable step in the control strategy was to manage and prevent runoff from corrals and manured areas. Once that was under control, the rates of application and/or disposal of manure could then be limited as the second step. The third and most difficult phase, if it could be achieved, would be total control of all waste materials through limits on wash water disposal.

The dairy community argued successfully that they could not fairly be held responsible for all rainfall circumstances and conditions, and a compromise formula was developed. At a minimum, dairies would be responsible for installing and maintaining runoff control facilities (dikes, berms, ponds, etc.) to address 24-hour rainfall events which were less than or equal to 1.3 times the 10-year storm (equal to the 25-year, 24-hour storm event). Despite the intent of the Regional Board staff, this formula had only minor effects on most existing dairy operations. A low berm was generally put up across the lower side of the property, and the subject was dismissed. Where it did have an effect, however, was when a new dairy was being designed, or an existing dairy was trying to come into compliance.

Multiplying the manured area (corrals and stockpile areas) times the rainfall figure allowed dairymen to calculate how much water they had to manage. Appropriately-sized retention ponds and disposal areas could be designed using the formula. Because of
steeper slopes and other features related to the location of some properties, however, there were still some dairies that found it difficult, if not impossible, to control storm-induced runoff, flooding, and other such problems.

In the process of developing the data and information needed for the computer modeling necessary to produce the 1975 Basin Plan, Albert A. Webb and Associates was contracted to study waste disposal in the dairy industry. Board staff worked closely with Webb and with the Santa Ana Watershed Project Authority (SAWPA), the Board's basin plan contractor, to develop acceptable salt loading rates from dairies and other agriculture (see Section III and Appendix A). The manure disposal limit that appears in the waste discharge requirements issued to the dairies, three tons per acre per year, resulted from those efforts. As the next section of this report discusses in detail, the objective in specifying the three tons per acre per year limit was to ensure that the dairy salt load was reasonably comparable to that from other land uses (e.g., urban and agricultural uses).

Manure is the major waste disposal problem at most dairies. Corrals are convenient, in that they keep the cows close to the barn; milking, feeding and watering are more efficient, as are the necessary routine veterinary procedures. But the manure is concentrated in a much smaller area where nothing grows, and it has
to be cleaned out, or at least scraped and piled, a couple times a year.

Permits that limited manure disposal to 3 tons/acre/year quickly made it clear to the dairymen that agricultural application at 10 to 20 tons/acre/year made a lot more sense, since they removed a lot more manure than simple disposal could. This issue will be covered in detail later in this report.

As a hydrologic system, the Chino Basin is closed. Water, salt and/or pollutants discharged to the ground in the Chino Basin move down toward Prado Basin and appear as rising water flows in the Santa Ana River. What has kept these pollutants from showing up sooner is a combination of the slow movement of these materials down through the unsaturated zone, and the slow movement of groundwater toward the River. Knowing that the impacts of waste disposal from the dairies would appear sooner or later, and that this activity would have serious water quality effects if it were unregulated, SAWPA and the Regional Board proposed during 1975 that the area be sewerized and the wastewater flows be treated. The wastewater would then have been discharged to the Santa Ana Regional Interceptor (SARI), the brine line, effectively exporting the washwater salts to the ocean.

The SARI line was approved by EPA, but the scheme to sewer the dairy area was not. EPA reportedly felt that sewerizing this
agricultural area would benefit the dairy industry, and would make urbanization much more likely to occur sooner. They did not want to encourage growth. This threat of growth must have seemed to EPA to be more serious than the threat to water quality. The ramifications of this failure to adequately address washwater disposal will be discussed in detail in a later section of this report.

In summary, the Regional Board dairy regulatory program developed in the early '70's addresses surface water protection through runoff controls and groundwater quality protection by means of limits on manure application rates. This program remains essentially unchanged today. The water quality problems described earlier in this report indicate that changes in this regulatory program are necessary. To understand these changes, a more detailed review of the rationale for specific aspects of the Board's requirements is necessary. That will be the focus of the next section of this report.
III. THE DEVELOPMENT OF THE REGIONAL BOARD'S DAIRY REGULATORY PROGRAM

A. Introduction

Manure wastes generated at dairies are temporarily or permanently deposited in areas that may impact both surface water and underlying groundwater. These areas include the corrals, washwater holding ponds, pasture, and croplands associated with the dairies. As described previously in this report, the Regional Board has established waste discharge requirements for dairies to protect surface and groundwater quality. These requirements are summarized in Table III-1. As shown in this Table, the Board's regulatory program addresses surface water protection through requirements for the containment of all dairy washwater and manured storm water (up to and including the 25-year, 24-hour storm), and for protection from 100-year storm flows which would inundate manured areas. To protect groundwater quality, the Board's requirements limit the application of manure to pasture (also known as disposal acreage (see Subsection C)) and croplands. Note that specific information is obtained from the dairy operator when a new or substantially modified dairy operation is proposed; annual reports submitted by the dairy operators allow Board staff to assess compliance with waste discharge requirements. To date, the Regional Board has not implemented any requirements to prevent groundwater degradation.
TABLE III-1

SUMMARY OF THE CURRENT DAIRY REGULATORY PROGRAM

Santa Ana Region

REPORTS OF WASTE DISCHARGE

- Name, address, phone number, etc.
- Proposed animal population
- Dairy, disposal land, and cropland acreage
- Plot plan (sketch) of the dairy and disposal areas
- Proposed method(s) of manure disposal
- General description of proposed wastewater disposal method and containment controls

WASTE DISCHARGE REQUIREMENTS

Surface Water Protection

- Containment of all washwater and storm runoff from up to and including a 25-year, 24-hour storm
- Protection from inundation from 100-year peak stream flows

Groundwater Protection

- 3 tons/acre of manure on disposal land
- Agronomic rates for manure application to cropland

ANNUAL REPORTS

- Name, address, phone number, etc.
- Animal population
- Dairy, disposal land, and cropland acreage
- Manure disposition (amount spread on disposal land, spread on cropland, stockpiled, or hauled away)
- Types of crops grown (if manure was spread on cropland)
- Hauler's name and location where manure was hauled
- Type of wash water disposal method used
- Statement regarding problems encountered during previous year

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from manure deposition in corrals or from the application of nutrients and salts deposited on the soil by the application of the dairy wash water to pasture. The following sections provide a detailed discussion of the rationale for each of these aspects of the Board's dairy regulatory program.

It should be noted that a significant portion of the manure that is generated by the dairies is reported to be transported away from the dairy areas; some is even hauled outside of the Santa Ana Region (see Chino Basin Dairy Data Sheet, Table I-8). Manure waste deposition in these areas can also pose water quality problems, however, the Board has not implemented any requirements to address such impacts. Any effort to do so would require the implementation of a manure accounting system to track the fate of manure wastes generated within the Region. This issue will be addressed in a later section of this report (see Section IV).

B. Dairy Operations

In order to understand the rationale that the Regional Board has employed to protect ground and surface waters from wastes generated by the dairies, it is first necessary to review the typical operation of the dairies, the sources and types of wastes generated, and typical disposal methods.
Most of the animals at an efficiently operated dairy will consist of milking cows which are maintained in corrals most of the time. Much of the waste generated by these animals remains in the corrals until it is removed on approximately a semiannual basis. The manure deposited in the corrals undergoes various degrees of decomposition, and since most of the corral floors are earth, the salts and nutrients that are present in dairy manure are subject to transport into and through the underlying soil of the corral by the infiltration of precipitation and moisture from fresh manure.

Dairy cows are typically removed from their corral twice each day for milking. Webb (1974) reported that approximately ten percent (10%) of the manure generated by milking cows is deposited in the water which is used to wash the cows prior to milking. Manured wash water is applied directly to pasture or cropland or is stored in a pond and then applied to pasture/cropland. Pond capacities generally prevent long-term storage of the manured wash water, and thus, the wastewater generated each day is usually applied to the agricultural land on a daily basis.

Approximately twice a year, the manure that has accumulated in the corrals is removed and applied to pasture and/or cropland or hauled away from the dairy. Pasture and cropland also receive the dairy wash water, which, as stated above, contains approximately 10% of the nutrients found in the manure.

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1 The term manure, as used in this report, includes all feces and urine excreted from the dairy cattle.

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percent of the total waste generated by the milking cows. A small percentage of dairies employ a "flush out" waste disposal system for their corrals. At these dairies, manure is routinely washed out of the corrals with water, routed to a holding pond and applied to pasture and cropland.

A typical dairy will also support nonmilking cows, replacement dairy cows, heifers and calves. When the condition of the pasture will allow (sufficiently dry with substantial grass), these animals are commonly maintained on pasture. Thus, the pasture will receive the manure excreted from these animals. However, much of the pasture also receives dairy wash water and manure from the corrals, which adds to the salts and nutrients applied to these lands.

For the purpose of understanding the relative proportion of lands that are being subjected to temporary or permanent manure deposition, the following table shows the amount of land in the Chino Basin dairy area used for corrals, pasture, and croplands:
Table III-2

Dairy Manure Land Use Within the Chino Basin Dairy Area

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acreage</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops and Hay(^1)</td>
<td>6,700</td>
<td>45</td>
</tr>
<tr>
<td>Pasture(^1)</td>
<td>6,280</td>
<td>42</td>
</tr>
<tr>
<td>Corrals(^2)</td>
<td>2,000</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,980</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

\(^1\)SCS (1988). Pasture = disposal acreage (see Subsection D)

\(^2\)Estimated from the 167,000 milk cows present in the Chino Basin dairy (Regional Board staff 1988 dairy survey) and assuming that each cow requires approximately 500 ft\(^2\) of corral area.

Thus, it appears that of the land which comes in contact with manure in the Chino Basin dairy area, approximately 45 percent is used for crops and hay, 42 percent is pasture and 13 percent has been developed as corrals.
C. Regional Board Dairy Requirements

The rationale for the Regional Board's surface water protection requirements is clear: washwater (which, again, contains about 10% of the total manure generated by milking cows) and stormwater runoff which has come into contact with manured areas must be contained on site in order to prevent adverse impacts to local and downstream surface waters. Surface runoff of such wastes in the Chino dairy area can ultimately affect the Santa Ana River. The Board's requirements are consistent with all the other extensive efforts being made to control water quality in that critical water body.

In the following subsections, those requirements which pertain specifically to groundwater quality protection are discussed in detail relative to the dairy land use identified above (Table III-2).

D. Pasture or Disposal Land

As previously noted, the Regional Board has specifically limited the amount of manure that can be applied to "disposal land" to 3 tons of manure (dry weight) per acre per year. This manure disposal requirement was developed in the early 1970's. At that
time, as has been previously described, it was well recognized that existing dairy practices (application of dairy manure and dairy wash water) were threatening underlying groundwater quality. The Santa Ana Watershed Planning Agency (now the Santa Ana Watershed Project Authority (SAWPA)), the Regional Board's Basin Plan contractor, sought methods whereby the salt loading from dairies could be reduced. Specifically, SAWPA's goal was to reduce the salt loading rate from dairies to 0.3 tons/acre/year, a rate which was consistent with those of other types of land uses (irrigated agriculture, urban, commercial and residential, etc.). This 0.3 ton/acre/year figure is roughly equivalent to the 230 mg/l mineral increment permitted at that time. [Salt loading rates, or unit factors, and their application in the Region's groundwater quantity and quality computer models (the Basin Planning Procedure) are described in detail in Appendix A. The application of mineral increments in setting waste discharge requirements is described in the 1983 Water Quality Control Plan (Basin Plan), pp. 4-3 and 4-4.]

SAWPA contracted with Albert A. Webb Associates, Consulting Engineers, to evaluate dairy waste management and disposal alternatives by which this 0.3 ton salt/acre/year loading rate could be achieved. Webb (1974), in turn, relied heavily on the research conducted by University of California at Riverside (UCR) personnel. A series of UCR reports were produced which provide specific guidance on the quantity and salt composition of wastes
generated by dairies and the amount of salt from those wastes that would be expected to migrate to underlying groundwater (University of California Committee of Consultants (UCCC, 1973a; UCCC, 1973b)). Using this information, the amount of manure that could be applied to achieve the 0.3 ton/acre/year salt loading rate to groundwater was calculated to be 3 tons manure (dry weight)/acre/year (Appendix B).

In summary, then, in establishing the 3 tons dry manure/acre/year disposal requirement, the Regional Board’s intent was to implement a regulatory mechanism which would limit the amount of salt leaching to groundwater from dairy operations to 0.3 tons/acre/year, consistent with other permitted salt loading rates. It is imperative to understand that, in order to achieve this salt loading objective, two things were required (and assumed):

The first requirement was that there be 100% compliance with the manure disposal requirement (3 tons/acre/year). Clearly, lack of compliance (i.e., manure application in excess of 3 tons/acre/year) results in salt loads in excess of the desired 0.3 tons/acre/year. The information provided in the 1987 Dairy Annual Reports submitted by the dairy operators indicated that there was good (95% or so) compliance with the manure disposal requirement. However, the fate of most of the manure generated is not clear. (The need for an improved reporting system to document the fate of manure within the
Region will be addressed in a subsequent section of this report.) If it is assumed that 50% of the manure is removed from the Chino Basin (an assumption which staff believes is rather generous) and the remainder is deposited within the Basin, the effective salt loading rate to groundwater from manure application alone was closer to 2 tons/acre/year.

The second requirement (and planning assumption) was that all dairy washwater be removed from the dairy area. As discussed earlier in this report (Section II), the third phase of the Board's proposed dairy regulatory strategy was the removal of dairy washwater from the area by sewering. At the time the manure disposal requirement was imposed (early 1970's), it was assumed that this phase would be implemented and that, therefore, no salt loading from washwater would occur. The maximum dairy salt load of 0.3 tons/acre/year could then be achieved. However, sewering of the washwater was not found to be feasible. No other equally suitable mechanism for washwater disposal has been identified or implemented to date. As described earlier, washwater continues to be applied daily to pasture and/or cropland as the primary means of disposal. Webb (1974) estimated that about 10% of the waste generated by a dairy cow is excreted in the washwater; therefore, washwater application results in an additional salt loading to groundwater of about 0.41 tons/acre/year.
It should be noted also that, at the time the manure disposal requirement was adopted, it was assumed that the application of manure as a fertilizer on cropland would not result in salt loads to groundwater in excess of typical, nondairy agricultural rates. As will be discussed below (Subsection F), this assumption was not justified.

Cumulatively, the effect of the degree of manure removal (about 50%) and the continued application of washwater in the dairy area results in a salt loading rate to groundwater of about 2.4 tons/acre/year, which is 8 times the salt loading unit factor sought by the Regional Board for the dairy industry\(^1\).\(^2\). This is summarized in Table III-3, below. Possible methods of addressing this excessive salt loading problem are discussed in a subsequent section of this report (Section IV).

\(^1\)As noted in Appendix A (unit factors), detailed model calibration work has been performed to update unit factors in conjunction with the watershed-wide Nitrogen study. Two recommendations regarding dairy salt unit factors have resulted (James M. Montgomery, Engineers, 5/1989 SAWPA Task Report). Montgomery found that the 2.4 tons/acre/year unit factor developed based on estimates of dairy waste removal (see Table III-3) was correct for historic dairy land use. But a salt unit factor of 2.54 tons/acre/year was recommended for present dairy operations.

\(^2\)Note from Appendix A, Table A-1 that the 2.4 dairy unit factor is 8 or more times the unit factors for other agricultural land uses and is 5 times the factor for residential and commercial uses (inside and outside).
### TABLE III-3

Salt Loading to Dairy Area (Pasture + Corrals)  
(tons/acre/year)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 tons manure/acre/year</td>
<td>0.3</td>
</tr>
<tr>
<td>Dairy Wash Water</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Assumes approximately 50% removal of dairy manure.

It must be emphasized that the figures shown in this Table for actual dairy salt loading are estimates (which recent model calibration studies have independently confirmed). In particular, the reporting system presently used to track manure disposal compliance is not sufficient to document the fate of all manure generated in the dairy area. As stated at the outset of this section, the fate of the manure that is reported to be hauled away is not known. An improved manure tracking system is necessary to accurately identify the salt loading to groundwater that can be attributed to dairy operations.

Certain issues have been raised concerning manure application on disposal land. It is appropriate to discuss these issues before moving to the discussion of the rationale for the Board's regulatory program with respect to dairy cropland and corral areas.
It has been recently debated whether pasture should be considered as "disposal land" or as "cropland", which is permitted a larger manure application rate (12 dry tons/acre/year). It is argued that nitrogen uptake in pastures is at least equivalent to that in cultivated croplands, and that, therefore, a higher application rate of manure should be permitted on pasture. It is true that from the standpoint of nitrogen removal, a bermuda grass pasture in good condition will take up approximately 225 pounds of nitrogen per acre, which is similar to many other nonlegume forage crops and exceeds the nitrogen requirements of most field crops (ie. barley, oats, corn, and wheat). Thus, from a nitrogen removal standpoint, a bermuda grass pasture, in good condition, will utilize nitrogen as much as other plants, which are considered to be crops. An even greater nitrogen uptake rate can be realized if the pasture is seeded with a winter grass to facilitate the utilization of nutrients on a year-round basis. However, an inspection of the Chino Basin dairy area provides insight as to why pasture has always been considered as disposal land and not cropland. In many cases, dairy manure is simply applied to the land without any effort to cultivate a pasture and the land remains fallow throughout the year since it is not seeded and irrigated. In other cases, marginal bermuda grass pastures have developed, but, during the winter months when the bermuda grass becomes dormant, no annual grasses are seeded to carry the pasture over to take up salts and nutrients in the manure applied during the winter. Under some
conditions, the pasture is irrigated with manured wash water, but is not seeded, which only promotes weed growth. The weeds are simply plowed under before the next application of manure. Under these conditions, crops are not consistently cultivated to remove the nutrients in the applied manure. These practices seem to be the rule rather than the exception, and for these reasons, staff continues to consider all pasture as disposal land. Moreover, as discussed above, pastures already receive additional nitrogen inputs through the application of dairy wash water.

E. Corral Areas

To date, the Regional Board has not regulated the deposition of manure waste in corral areas. Corral areas compose approximately 13 percent of the land that comes in contact with dairy manure and large quantities of manure are permitted to accumulate between corral cleanings. Since the manure contains substantial quantities of salts and nutrients, it is logical to assume that underlying groundwater quality is significantly threatened by the leaching and subsequent infiltration of these constituents into the underlying soils. However, while it may appear that the salt and nutrient loadings from corral areas are a significant source of dairy manure contamination, several studies suggest otherwise.
Nitrate and salt in soils underlying corrals, pasture, and cropland in the Chino Basin dairy area was studied by Adriano et al. (1971). Soil borings were performed in corrals, pasture, croplands, and in undisturbed areas. The highest concentrations of nitrate and chloride measured in saturated soil extracts were observed beneath the corral area at depths to 9 meters (100 ppm NO$_3$-N, 1000 ppm Cl), as compared with pasture concentrations (35 ppm NO$_3$-N, 100 ppm Cl), cropland concentrations (25 ppm NO$_3$-N, 50 ppm Cl), or background concentrations (10 ppm NO$_3$-N, 15 ppm Cl). However, the concentrations of nitrate and chloride in the shallow groundwater (approximately 11 to 17 meters beneath the ground surface) collected at each of the 15 sites was greater under the pasture (5.27 ppm NO$_3$-N, 7.09 ppm Cl), when compared with corrals (4.10 ppm NO$_3$-N, 3.88 ppm Cl), cropland (3.21 ppm NO$_3$-N, 2.86 ppm Cl), or undisturbed background concentrations (1.86 ppm NO$_3$-N, 3.15 ppm Cl). It was concluded that corrals contributed more nitrates than pasture or cropland on a unit area basis, but that the area of corrals constitutes only 5 percent of the total land area available for irrigation (this report has estimated 13 percent of the land subject to the application of manure). Therefore, Adriano et al. (1971) suggested that the mass of salts and nutrients leaching from cropland or pasture is greater since the land area is much larger.

The leaching of salts from corrals can also be expected to be less than pasture and cropland because irrigation water is not applied to the corral areas. Only precipitation that falls directly within
the corrals or rainfall runoff that enters the corrals and
infiltrates into the underlying soil will transport salts and
nutrients to the underlying groundwater. Thus, salt and nitrate
movement is probably much slower below corrals when compared with
transport of these constituents through the soil from pasture or
croplands. The soils under corrals are also heavily compacted from
the continuous load of the dairy cows, which may reduce the
hydraulic conductivity of the soil (and, therefore, the transport
of salt and nitrate) significantly (Chang, 1973).

To date, the Regional Board has not regulated the deposition of
manure in the corral areas because the contribution of salts and
nitrates to groundwater from these areas is small compared with
the leaching of salts from pasture and croplands.

F. Croplands

Within the last few years, the Regional Board has implemented a
requirement limiting manure loading to croplands to agronomic
rates. As a general rule of thumb, staff considers application
rates in excess of 12 tons/acre/year to be of concern, unless the
dairyman can demonstrate that more manure is required to meet the
agronomic needs of the crops. The 12 tons/acre/year "flag" was
implemented by staff because 12 tons of manure meets the necessary
nitrogen requirements of many double cropped land management scenarios employed within the Santa Ana Region.

Figures III-1a and III-1b present the estimated salt (TDS) and nitrate loading to the groundwater and the amount of nitrogen applied to the soil for manure application rates varying from 0 to 24 tons/acre/year. The TDS loadings were determined using the rationale developed by the University of California Water Quality Task Force, Committee of Consultants (UCCQ), as presented by Webb (1974) (see Subsection D, p.III-8 and 9; Appendix B). The regression equation used for the computation of these loadings is shown in Appendix B. As shown in Figure III-1b, the total nitrogen applied each year to the soil is approximately 400 lbs. N/acre at the 12 ton/acre manure application rate. The loading rate of nitrogen assumes that 50 percent of the nitrogen present in the fresh manure has volatilized. This total nitrogen application rate appears to be sufficient for many double crop management systems such as oats-sudan grass or barley-corn. However, it is possible to cultivate crops which require more nitrogen such as the combination of barley in the winter and sudan grass in the summer. Triple cropping has also been reported in some instances. The utilization of nitrogen by crops commonly cultivated in the Santa Ana Region are listed Table III-4.
TABLE III-4

Nitrogen Utilization by Various Crops

(Western Fertilizer Handbook)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pounds Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>160</td>
</tr>
<tr>
<td>Oats</td>
<td>115</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>250</td>
</tr>
<tr>
<td>Sudan grass</td>
<td>325</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>480</td>
</tr>
</tbody>
</table>

1Total uptake in harvested portion.

2Legumes are capable of fixing nitrogen from the atmosphere and, therefore, actual application of fertilizer can be significantly less.

As shown above, a winter crop of barley combined with a summer crop of corn (silage) requires approximately 400 lbs. of nitrogen. Similarly, sudan grass and oats need approximately 440 lbs. of nitrogen.

There is concern by staff that the use of manure on cropland, even at agronomic rates, may not be protective of underlying groundwater quality. Specifically, the concern is that the use of manure to meet the nutrient requirements of crops results in the excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater. This concern is described in more detail below.
Dairy manure contains much more salt per unit of nitrogen than other types of chemical fertilizers. A comparison of the types of fertilizer that might be applied to land and their respective salt content is informative. Table III-5 presents the salt content of three fertilizers that might be utilized.
### Table III-5

Comparison of Salt Compositions in Fertilizers

<table>
<thead>
<tr>
<th>Ion</th>
<th>Regional Mix</th>
<th>15:15:15 Blend</th>
<th>Dairy Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>0</td>
<td>147</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>0</td>
<td>292</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>80</td>
<td>28</td>
</tr>
<tr>
<td>Cl</td>
<td>8</td>
<td>73</td>
<td>82</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>45</td>
<td>173</td>
<td>123</td>
</tr>
<tr>
<td>HPO₄³⁻</td>
<td>14</td>
<td>143</td>
<td>188</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>359³</td>
<td>443</td>
<td>443</td>
</tr>
<tr>
<td>Total Salts</td>
<td>584</td>
<td>912</td>
<td>1,370</td>
</tr>
<tr>
<td>Nonnitrogen Salts</td>
<td>225</td>
<td>469</td>
<td>927</td>
</tr>
<tr>
<td>Non Nitrogen/ Total Salts Ratio:</td>
<td>39%</td>
<td>52%</td>
<td>68%</td>
</tr>
</tbody>
</table>

³For the purpose of developing a salt loading unit factor for agricultural uses other than dairies, a regional fertilizer mix was formulated on a weighted basis using fertilizers commonly used within the Region (WRE, 1970). See Appendix A for additional discussion.

²40% ammonia sulfate, 33% diammonium phosphate, 25% muriate of potash, and 2.5% urea.

³Soil microorganisms uptake and volatilization of ammonia were estimated by WRE (1970) to reduce this value from 443 lbs. to 359 lbs. Volatilization losses for the 15:15:15 Mix and dairy manure were accounted for before application to land and microorganism uptake was assumed to be negligible.
As shown in Table III-5, dairy manure contains much more salt per unit of nitrogen (68%) than either the 15:15:15 fertilizer mix (52%) or the regional mix (39%). The 15:15:15 mix was specifically selected for comparison because it represents a chemical fertilizer with a relatively high salt index. On the basis of fertilizer applied to the land, dairy manure contains at least twice as much total salt as commercial fertilizers. The regional fertilizer mix has less than half of salts contained in the high salt index 15:15:15 mix and one-fourth of salts present in dairy manure. The regional mix consists primarily of urea and anhydrous ammonia which are referred to as high analysis fertilizers. Generally, high analysis fertilizers exhibit lower salt indexes, and the prudent use of such fertilizers may result in much less salt applied to agricultural land.

Not all of the salt that is applied to land from fertilizer will leach to the groundwater table. Plants will take up significant amounts of nitrogen and, to a much lesser degree, some of the other salts contained in the fertilizer. Some of these other salts will precipitate to form relatively insoluble compounds that remain in the soil. On the order of one-half of the salts originally applied to the soil will be transported to the groundwater; the actual amount depends on a variety of factors which can be considered in a computer model. Staff conducted some model simulations to evaluate the amount of salt which leaches to groundwater from each of the three fertilizer types identified above. The modelling
Techniques employed are described in Appendix A (Model Evaluation of Salt Leaching from Fertilizers). The results of the simulations are summarized below:

Figure III-2 presents the total salt (TDS) loading rates for dairy manure, the 15:15:15 fertilizer blend, and the regional fertilizer mix relative to the amount of nitrogen applied to agricultural land. Table III-6 exhibits the data which were used in Figure III-2. As shown in Figure III-2, the dairy manure salt loading rate to the groundwater table is approximately twice as much as the salt loading rate for the high salt index 15:15:15 blend and four times as great as the regional mix. For applications of fertilizers at application rates common for the Chino Basin dairy area, the relationship of application rate and groundwater loading rate is relatively linear. Thus, increases in the amount of fertilizers applied to the soil will result in a proportionate increase in the amount of salt entering the underlying groundwater aquifer.

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Total Nitrogen Application Rate (lbs. N/acre/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>0.48</td>
</tr>
<tr>
<td>15:15:15 Blend</td>
<td>0.29</td>
</tr>
<tr>
<td>Regional Mix</td>
<td>0.12</td>
</tr>
</tbody>
</table>

III-23
TDS Leaching vs Fertilizer Type

Nitrogen Application (lbs N/acre/year)

TDS Loading Rate (tons/acre/year)

- Dairy Manure
- 15:15:15 Blend
- Regional Mix

Figure III-2
A second evaluation was performed to determine the amount of nonnitrogen salts leaching to groundwater for the three fertilizer types. This evaluation was performed by subtracting out the nitrogen from the total salt loading factor. For these fertilizer types, the amount of nitrogen (nitrate) leaching to groundwater was similar for the total nitrogen application rates considered. Figure III-3 presents the nonnitrogen salt loading rates to groundwater. The specific loading rates used to generate Figure III-3 are exhibited in Table III-7. Again, the comparison shows that the application of dairy manure to the soil results in a much higher loading rate for nonnitrate salts when compared with the other fertilizers. In addition, by comparing Figures III-2 and III-3 it can be observed that approximately 25 percent of the total salts leaching to the groundwater are nitrogen, which will be in the form of nitrate. For the other fertilizers, the amount of nitrogen leaching beyond the root zone is approximately 50 percent of the total salt load. This is not surprising since dairy manures contain significantly more salt than other types of the fertilizers.
Nonnitrogen Salt Leaching vs Fertilizer Type

Nitrogen Application (lbs N/acre/year)

Dairy Manure
15:15:15 Blend
Regional Mix

Figure III-3
Table III-7

Nonnitrate Salt Loading Rates (tons nonnitrate salts/acre/year) vs Fertilizer Types

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Total Nitrogen Application Rate (lbs. N/acre/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>0.37</td>
</tr>
<tr>
<td>15:15:15 Blend</td>
<td>0.18</td>
</tr>
<tr>
<td>Regional Mix</td>
<td>0.03</td>
</tr>
</tbody>
</table>

In summary, dairy manure contains much more salt per unit of nitrogen than the other fertilizer types evaluated. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which migrate to groundwater. Based on these findings, staff believes that it is appropriate to consider revising the Board’s present regulatory strategy with respect to manure application on cropland. These and other conclusions and recommendations regarding the Board’s dairy regulatory program as a whole are discussed in a subsequent section of this report.

Before moving to this discussion, it is appropriate to emphasize an important point regarding the preceding discussion. The salt loading unit factors described here and in Appendix A are used in the Region’s computer models (the BPP) to make projections of water
quality over time. These projections, in turn, have proven extremely useful in identifying optimal waste management and regulatory strategies (which have been incorporated in the Basin Plan and implemented through waste discharge requirements). But it should not be construed from this that our knowledge of dairy waste impacts on groundwater quality in the Region is a truly exact science. The figures given for salt loading to groundwater from present dairy operations are estimates, based largely on the information submitted in the dairy annual reports. As previously noted, the information submitted in the annual reports is not adequate to identify the fate of all the manure generated and potentially disposed of in this Region. Because of this inadequacy, our understanding of the real impacts to groundwater of dairy waste management and disposal practices, both within the dairy area per se and elsewhere in the Region, is necessarily limited. This signals the need both for an improved manure disposal tracking and reporting system and for a comprehensive groundwater monitoring program so that more accurate, in the field knowledge of the impacts of dairy operations on groundwater quality can be obtained (and used to refine our chief basin planning tool, the BPP). Additional discussion regarding these needs is to be found in the final section of this report.
IV. SUMMARY AND PROPOSED REGULATORY STRATEGY

As stated earlier in this report, the Regional Board's dairy regulatory program has not changed significantly since its inception in 1972. Based on the findings presented herein, Board staff believes that it is imperative to consider methods of addressing the excessive salt loads which result from dairy operations. Clearly, such methods could include substantive modifications of the Board's regulatory approach. Staff has developed a proposed dairy regulatory strategy which should allow the dairy industry to continue doing business while at the same time protect surface and groundwater resources. To put the proposed measures in context, it is worthwhile to review the salient points made in the preceding sections of this report.

Summary of Key Points

1. There is a severe groundwater quality problem with respect to TDS and nitrate in the Chino Basin. Modelling projections show that TDS and nitrate concentrations will continue to increase significantly over time. Both the Chino II and Chino III groundwater subbasins lack assimilative capacity for additional salt inputs.
2. This groundwater quality problem causes three major concerns:

a. High nitrate and TDS concentrations adversely affect the use of Chino Basin groundwater for municipal, agricultural and industrial supply.

b. Poor quality groundwater (and salts now present in the unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of MWD's proposed Storage Program.

c. Poor quality groundwater in the Chino Basin ultimately rises into the Santa Ana River, significantly affecting surface water quality. Recent studies (watershed-wide nitrogen study) show that rising groundwater accounts for approximately 30% to 40% of the nitrates measured at Prado Dam and about 50% of the TDS. Since Santa Ana River flows are used to recharge the Orange County drinking water aquifer, poor quality rising groundwater from the Chino Basin ultimately affects the quality of waters supplied to Orange County residents.

3. Recent Basin Plan update modelling studies have shown that the construction and operation of groundwater desalters will be necessary to address this groundwater quality problem. SAWPA is already pursuing the implementation of these
facilities in conjunction with other agencies. A primary effect of the operation of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. It is estimated that the cost of desalter operations will be in the range of $320 to $690 for every ton of salt removed.

4. It is evident that while irrigated agriculture and municipal wastewater disposal have contributed to this groundwater quality problem, dairy wastes play an overwhelmingly significant role:

a. Basin Planning Procedure (BPP) results (1983 model runs) show that agricultural land uses account for about 97% of the salt load added to groundwater in the Chino basin dairy area; dairies account for about 88% of this agricultural salt load.

b. Basin Planning Procedure (BPP) data indicate that dairy waste discharges account for about 60% of the total salt load added to groundwater in the Chino Basin as a whole between 1958 and 1986.

c. A special model run was made in order to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in
the Basin. This model run shows that the dairies have a significant effect on the quality of groundwater, particularly in the Chino II and III groundwater subbasins. The removal of dairy operations results in significant decreases in both the concentrations and total masses of TDS and Nitrate.

d. Based on data compiled from the 1988 Dairy Annual Reports, dairies in the Chino Basin area generated a total of 132,020 tons of salt (see Chino Basin Dairy Data Sheet (Table I-8)). Of this amount, approximately 70,768 tons per year are estimated to remain in the Chino Basin. Using the regression equation described in Appendix B, approximately 27,631 tons of this salt load will reach Chino Basin groundwater per year. Note that if we assume that the cost of a desalter is $320 per ton of salt removed, the total cost of removing this dairy salt load to groundwater would be roughly $8.8 million per year. This would be the cost to mitigate only the impacts of ongoing operations, not historic impacts.

5. The Regional Board's dairy regulatory program, developed in the early 1970's, includes requirements for both surface water and groundwater protection (see Table III-1).
In formulating groundwater protection requirements, the Board’s intent was to ensure that the dairy salt load to groundwater was reasonably comparable to that from other land uses (urban, other agriculture, etc.), that is, approximately 0.3 tons salt/acre/year (this is roughly equivalent to the 230 mg/l mineral increment permitted at that time). To reach this objective, the Board limited manure disposal on disposal acreage to 3 tons (dry)/acre/year. It was thought that this limitation would meet the Board’s salt loading objective for dairies, provided that:

a. There would be 100% compliance with the manure disposal requirement (3 tons/acre/year); and,

b. All dairy washwater would be removed from the dairy area. (Wash water contains about 10% of the total salt load generated by dairy operations.)

It was assumed in the early 1970’s that the application of manure as a fertilizer on cropland would not result in salt loads in excess of nondairy agricultural rates. However, this assumption was not justified (see §6, below).

6. Within the last few years, the Regional Board has implemented a requirement limiting manure application to croplands to agronomic rates. Staff’s recent analysis of this regulatory
approach indicates that manure application on croplands, even at agronomic rates, is not protective of water quality. Dairy manure contains much more salt per unit of nitrogen than other types of fertilizers. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater.

7. The actual salt loading rate to groundwater from dairy operations is about 2.4 tons salt/acre/year, or roughly 8 times the Board's objective (0.3 tons/acre/year). [Recent studies (watershed-wide nitrogen study) indicate that the dairy salt unit factor should be 2.54 tons/acre/year]. Several factors are responsible for this excessive salt loading:

a. It is estimated that only about 50% of the manure generated in the dairy area is exported from Chino Basin (while dairy annual reports suggest generally good compliance with the Board's manure disposal limitation, the fate of the remaining manure is not documented. Independent model studies confirm that the estimate of 50% manure removal is reasonable.)
b. No washwater has been removed from the dairy area; wash water (with its associated salt loads) continues to be applied to dairy pasture and cropland.

c. There is ongoing manure application to cropland. Even at agronomic rates, cropland application results in the migration of excess salts to groundwater.

8. The dairy salt unit factor is used in the BPP to make water quality projections over time. These projections have proven extremely useful in identifying optimal waste management and regulatory strategies. But our knowledge of the impacts of dairy waste management and disposal practices on groundwater quality in the Region is not an exact science:

a. The dairy salt loading unit factor used in the BPP is an estimate, based largely on the information supplied in the Dairy Annual Reports. (Recent BPP calibration studies indicate that it is a reasonable estimate). However, this reporting system is not adequate to document the fate of all manure generated in the dairy area. A significant portion of this manure is reported to be hauled out of the dairy area, but the fate of this manure is not known. It is assumed that 50% of this manure remains in the Chino Basin and, thereby, significantly increases the dairy salt load to
groundwater. Because of our incomplete knowledge of manure disposal practices, our understanding of the real impacts of dairy operations on groundwater is necessarily limited. An improved manure tracking and reporting system is necessary to accurately document the fate of the manure (and associated salts) generated in the dairy area.

b. The groundwater quality data used in the BPP to make future quality projections were derived from available sampling results from a limited number of wells within the Chino Basin. While these data are sufficient to conclude that significant degradation is occurring in the Chino Basin, additional data are needed to obtain a clearer understanding of the extent and nature of this problem. Such data would be used to refine the BPP, which, in turn, would be used for future planning and mitigation activities. A comprehensive groundwater monitoring program is necessary to provide accurate, in-the-field knowledge of the impacts of dairy operations on groundwater quality. The implementation of groundwater monitoring requirements on dairy operators would be consistent with established practice for other waste dischargers in the Region.
9. Surface waters within and downstream of the Chino Basin are also adversely affected by dairy operations. This problem results, in part, from inadequate dairy waste management programs, including containment controls. In addition, uncontrolled stormwater runoff from rapidly developing urban areas upstream of the dairy area impacts the integrity of the dairy containment controls that are in place, leading to discharges of manured wastewater to surface waters.

**Proposed Dairy Regulatory Strategy**

Based on the findings summarized above, staff believes that the following measures should be considered to understand, control and correct the water quality impacts of dairy and other animal confinement operations in the Chino Basin. These measures constitute a comprehensive three-part program: Part I is designed to address the present and future impacts from ongoing dairy activities in the Basin; Part II addresses the impacts from past dairy activities; and Part III addresses the need for improved drainage facilities upstream of and within the dairy area.

It should be noted that the word "dairy" has been used somewhat loosely throughout this report. The impacts of waste discharges from other types of animal confinement facilities (heifer ranches, calf nurseries, beef cattle feed lots, etc.) are similar to those.
of dairies. Consequently, any strategy proposed to address the impacts of animal waste discharges in the Chino Basin should apply to all animal confinement facilities, not only dairies. All further references to dairies should therefore be understood to apply to all animal confinement facilities.

Part I - Dairy Waste Discharge Requirements: Impacts of Ongoing Operations

Staff has identified four specific areas in which the Board's present animal confinement facility waste discharge requirement program should be revised and improved to address the impacts of present day discharges of manure and manured wastewater. These are: an improved manure tracking system, an improved groundwater monitoring program, a revision of the manure and wastewater disposal/application requirements, and a requirement for engineered waste management plans to be included as a part of Reports of Waste Discharge. Each of these measures is discussed in detail below:

1. Implement an improved manure tracking and reporting system.
   A manifest system similar to that now used for hazardous waste should be implemented. A sample manure tracking manifest is included as Appendix E. Under this system, written documentation of the amount of manure hauled from a dairy, the hauler's name and the location of final disposal or use as
fertilizer would be described. The owner/responsible party of the land where the manure is applied would acknowledge its final disposition and return the manifest form to the point of origin (dairy operator). The dairy operator would be required to record this information and submit it annually to the Board. Such a manifest system would significantly enhance staff's abilities to: (1) evaluate the full effects of dairy waste management practices on groundwater quality in the Region; and, (2) determine compliance with present (and future) manure disposal requirements. The implementation of this system would likely have significant resource implications for both the dairy industry and Regional Board staff. Given the severe deficiencies of the present reporting system, staff believes that it is essential to implement this program despite the resource constraints.

This manifest program will require that the dairy operators take much more care and time in accounting for the final disposition of each load of manure reported to be hauled away. The dairy operators may have difficulty in obtaining all of the manifests from the landowners/responsible parties who have accepted the manure. This problem can be corrected if the initial agreement between the dairy operator and the landowner/responsible party identifies the use of the manifest system as one of the conditions for receipt of the manure.
2. Implement groundwater monitoring requirements on dairy operators.

Several options are available to the Regional Board to obtain the comprehensive groundwater quality data which staff believes is necessary for planning and mitigation activities:

1) The Board could include groundwater monitoring requirements in the waste discharge requirements of every dairy operator;

2) The Board could include groundwater monitoring requirements in waste discharge requirements, as in "1" above, but could also specify an option of participation in a cooperative, comprehensive monitoring program conducted by the dairy industry or other parties; or,

3) The Board could forego the incorporation of monitoring requirements in waste discharge requirements provided that a comprehensive monitoring program is in place.

The inclusion of monitoring requirements for each discharger in waste discharge requirements would be consistent with established regulatory practice. However, staff recognizes that a number of agencies (SAWPA, Chino Basin Watermaster,
MWD) are already developing programs to obtain comprehensive, long-term groundwater quality data in the Chino Basin. The Chino Basin Watermaster has recently completed a monitoring program of the Chino Basin and has proposed to continue this effort next year. In light of these efforts, a cooperative program, whereby the dairy industry would participate in the other agencies' monitoring efforts, appears more appropriate and reasonable than individual dairy operator monitoring.

Staff recommends the second option as the most effective and reasonable compromise; that is, incorporate monitoring requirements in each dairy operator's waste discharge requirements, with the option for in-lieu participation in an established, comprehensive monitoring program. Participation in such a comprehensive program should result in substantial cost savings to the dairy operators. For example, the Watermaster's monitoring program was estimated to cost only $8,000 per year for the entire industry. For the current effort, the Watermaster has provided funding to cover the dairy industry portion of this monitoring.

3. Revise the manure and washwater disposal requirements in dairy Waste Discharge Requirements.

As described previously, the Chino II and III groundwater subbasins lack assimilative capacity for additional salt
inputs. In basins without assimilative capacity, mineral increments are not permitted when regulating waste discharges [1983 Basin Plan (p.4-4) and State Water Resources Control Board Order No. 73-4 (the "Rancho Caballero" decision)]. This means that the quality of waste discharged to such basins must meet Basin Plan objectives. To meet Basin Plan objectives in the Chino Basin and thereby comply with the Basin Plan and the State Water Resources Control Board order, the discharge of manure and washwater, and their application as fertilizer and irrigation water, cannot be permitted. Waste Discharge Requirements must be revised to reflect this prohibition. Again, this would apply to the application of manure and washwater to cropland, as well as to the discharge of these wastes to disposal (pasture) land.

Staff recognizes the practical impediments to the prohibition of manure and washwater disposal/application. It was recognized in the early 1970's that washwater removal would be necessary to meet the dairy salt loading objective, but no practical method for washwater disposal has, as yet, been identified. Similarly, suitable methods/locations for manure disposal have been difficult to identify, although Chino Basin Municipal Water District is now in the process of implementing a manure composting facility which should significantly alleviate manure disposal problems in the Basin. Preliminary information indicates that this facility will have the
capacity to handle approximately 50% of the manure now generated in the basin.

Recognizing that it is likely to be difficult to overcome, in whole or in part, the practical constraints to the prohibition of manure and wastewater disposal or application in the Chino Basin, staff believes that it would be appropriate to incorporate an offset provision in the dairy waste discharge requirements. Requirements for participation in offset programs have precedence in the Santa Ana Region; where waste discharges cannot be eliminated or improved in quality, the discharger is required to mitigate the impacts of that discharge through an approved offset program. The same approach could be employed with dairy operators; for every ton of salt that will reach groundwater as a result of continued disposal/application of manure or wastewater within the Chino Basin, the dairy operator must remove an equivalent amount of salt through participation in an acceptable offset program. Such an offset could include financial participation in the Chino Basin desalter operations which have been discussed previously.

It should be noted that the offsets required would depend on the dairy industry's success in identifying acceptable methods of manure and wastewater disposal; the more manure and wastewater that is removed from the basin, the less the needed
offset. Manure and wastewater disposal outside of the Basin is likely to be more cost-effective than participation in desalter operations: generally, it's less expensive to avoid a problem than to correct it. A number of disposal opportunities could be explored by the dairy industry:

a) Hauling the manure out of the basin to areas that can assimilate additional salt loading.

b) Financial participation in proposed composting facilities such as the one being implemented by the Chino Basin Municipal Water District. This would be acceptable only to the extent that the composted manure is removed from the basin. Indications from Chino Basin Municipal Water District are that markets for the composted manure to be produced by their proposed facility will be largely out of the Basin.

c) Financial participation in proposed waste-to-energy facilities. (Facilities have been proposed in the past which will convert manure into electricity and discharge the salt and other waste materials in an environmentally safe manner.)

Again, the amount of financial participation by the dairy industry in any of these, or any other methods of reducing
the amount of manure that is discharged, may be considerably less than the cost of extracting the salt from the basin after it reaches groundwater (i.e., through participation in desalters). Note, however, that these manure disposal options do not address washwater; continued washwater application in the Basin will require mitigation through an appropriate offset program.

In summary, staff recommends that the waste discharge requirements for dairy operators in the Chino Basin be revised as follows:

a) Prohibit the disposal of manure and washwater, and their application as fertilizer or irrigation water, in the Chino Basin; and,

b) Incorporate an offset provision, whereby the dairy operator could offset the water quality impacts of continued manure and/or washwater disposal/application practices.

Two things about these recommended changes are important to understand. First, the intent of the changes is to keep pace with ongoing dairy operations to prevent further groundwater quality impacts to the Chino Basin. Second, these changes would not impose any unreasonable burden on the dairy
operators; the operators would simply be required to mitigate the impacts of the salt loads for which they are responsible.

4. **Require the preparation and submittal of an engineered waste management plan as part of the Report of Waste Discharge.**

   It was noted at the beginning of Section III that the Board has implemented specific requirements on dairy operations to protect surface waters. These include requirements for the containment of all washwater and all storm water runoff from manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Under the Board's current regulatory program, the dairy operator must provide a general description of the proposed containment controls as part of the Report of Waste Discharge. Staff experience in the dairy area indicates that this is not adequate.

   Because of limited staff resources, only a fraction of the dairies within the Region have been routinely inspected over the last several years to evaluate the adequacy of the containment controls proposed and implemented by the dairy operators. Even when inspections are conducted, problems with the controls are not always readily apparent; what may appear to be adequate in the field during the dry season may actually
fail to work properly when it rains. Discharges to surface waters may therefore occur. Enforcement actions resulting from these discharges frequently include the requirement that an engineer or other qualified person develop a waste management plan for the facility. This plan must then be implemented by the dairy operator.

It would be far more effective, and more efficient, to require that a properly engineered waste management plan be developed and submitted with the Report of Waste Discharge. This plan would be developed by a civil or agricultural engineer, a member of the West End Resource Conservation District or the Soil Conservation Service, or another qualified individual approved by the Executive Officer. The plan would include an evaluation of the existing waste containment controls and a detailed proposal for the additional containment controls, if any, that would be necessary to insure containment of the wastes generated on the dairy. In addition, the waste management plan would include a description of necessary operations and maintenance procedures (e.g., how often check valves should be left on in various fields, when manure should be removed from holding ponds (if these ponds continue to be utilized), activities necessary to control gopher and/or squirrel problems, etc). Appendix F contains a sample list of the items that should be included in waste management plans. A stipulation would be included in the waste discharge
requirements that the author of the waste management plan inspect the site facilities during construction and at the completion of construction to verify that the waste containment controls were built according to the recommended plan.

This requirement for an engineered waste management plan would be in effect for all animal confinement facilities requiring the submittal of a Report of Waste Discharge (new facilities, as well as existing facilities where the herd size has increased, the type of operation has changed, or the operators have changed). In the case of a change in operators, the submittal of an engineered plan developed by the previous operator would be acceptable, as long as there is no material change in the operation (i.e., herd size remained the same).

The implementation of this plan should significantly reduce the frequency and magnitude of surface water discharges from dairies, in addition to protecting water quality. This would have the advantage of reducing staff expenditures on enforcement actions. The Board has recently acted on a number of dairy Administrative Civil Liability complaints resulting from illegal manured wastewater discharges. In each case, the fine was suspended provided that the operator submit and implement an engineered waste management plan. Had this plan been developed and implemented earlier, the discharges and
subsequent enforcement action need not have occurred. This recommended approach is consistent with the recommendations of the Department of Water Resources in comments on proposed dairy waste discharge requirements (see Appendix D as an example).

Part II - Impacts From Past Dairy Practices

Part I of the recommended strategy deals with the abatement of the impacts of ongoing discharges of dairy wastes within the Chino Basin. Part II addresses the mitigation of the water quality impacts that past discharges of dairy wastes have caused within the Basin.

Water quality objectives for the Chino II and Chino III groundwater subbasins are being exceeded. Correction of this problem is imperative to protect the beneficial uses of those subbasins, and to prevent adverse impacts to the Santa Ana River and its downstream beneficial uses.

Responsibility for this water quality problem by dairies, other types of agriculture and other sources has been previously delineated in terms of the salt loads contributed to the Basin by each of these sources. Staff recommends that the responsibility for cleanup of the Chino Basin be assigned among these sources in
proportion to their salt load contributions. In this way, no one source would be asked to bear an unreasonable share of the cleanup burden: each source would be asked (or required) to assume only their fair share.

A number of different approaches could be utilized to define the proportional responsibility for each source. One method would be to employ data regarding salt added to the Basin by each source from the time that dairies began operation in the Chino Basin. Basin Plan model data indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 were presented earlier in this report. Under this approach, the dairies would be responsible for approximately 60% of the cleanup which is ultimately determined necessary to correct water quality degradation in the Chino Basin (see Table 1, Section I). Note that this may not require the removal of all salts added by the dairy industry, or by others.

An alternative method of assigning proportional responsibility could be based on the salt contributions by each of the various sources since the assimilative capacity for additional salt input into the Basin was reached. Other methods using different types or subsets of salt load data (or other data) could also be utilized. The determination of the specific proportional responsibility to be assigned to dairies or any other source is
beyond the scope of this report and must await subsequent analysis and consideration. What is being proposed herein is the concept of proportional responsibility and the use of that concept to develop an equitable approach to water quality correction in the Chino Basin.

As stated earlier, Basin Plan modelling studies confirm that desalter operations will be an integral element of any Chino Basin cleanup strategy. The implementation of these desalters is already being pursued by other agencies within the Region. Other measures may be required. Staff believes that the costs of implementation and operation of any of these measures should be borne by all the sources of salt input, again, in proportion to their salt contributions.

It is recognized that the costs of cleanup in the Chino Basin will be large and may impose a significant burden on the dairy industry or other sources. A source of funding which the dairy industry, and other sources, are encouraged to explore is the formation of integrated financing districts, whereby liens would be placed on properties and collected when the properties are sold. The funds would then be used to fund cleanup projects. It has been noted that other agencies with water quality interests in the Chino Basin are already pursuing the implementation of some cleanup measures. Financial participation in these facilities may to some extent alleviate the costs to the dairy industry per se.
The Board could take two approaches to ensure that the dairy industry's portion of the cleanup program described above is achieved. One approach would be through enforcement orders (Cleanup and Abatement Orders) issued to each dairy operator. Alternatively, the Board could accept the voluntary commitment by the dairy industry to ensure that the necessary cleanup is accomplished. If said cleanup was not accomplished in this cooperative atmosphere, the Board could resort to appropriate enforcement. The choice of approach clearly rests with the Board, and with the dairy industry.

Part III - Surface Water Quality Impacts: Control of Urban Drainage in the Chino Agricultural Preserve

The third part of the recommended Chino Basin strategy addresses surface water drainage problems in the dairy area caused by runoff from upstream urban development. As discussed previously, this urban runoff creates additional difficulties for a number of dairy operators in complying with the manured water containment requirements contained in their waste discharge requirements. Recommendations are presented below to address this problem. It must be emphasized that these recommendations are directed to the counties and cities, rather than to the dairy industry.
A number of studies have been conducted to determine the best method of preventing urban stormwater runoff impacts in the Chino Basin dairy area. The most recent study, conducted with federal 205(j) planning funds, was completed in 1987 ("Chino Agricultural Preserve Drainage and Land Use Study"). The recommended solution to urban drainage problems was the construction of a trapezoidal earth swale at the northern boundary of the dairy area (roughly, at Riverside Avenue, between Campus Avenue and the Cucamonga Creek flood control channel (just west of Archibald Avenue)). This swale would intercept flows from upstream urban areas (cities of Ontario and Chino) and convey these flows to the Lower Cucamonga Spreading Grounds, adjacent to the Cucamonga Creek channel.

Funding for this measure was sought through the Agricultural Drainage Water Management Loan Program administered by the State Water Resources Control Board (State Board), but the project did not qualify. A new source of money has recently become available through the State Revolving Fund Loan Program. The State Board is proposing to set aside a minimum of $5 million of FFY 1991 State Revolving Fund monies for the purpose of issuing loans for eligible nonpoint source and/or estuary enhancement activities. Staff believes that the swale project will qualify as a nonpoint source project. The San Bernardino County Department of Transportation and Flood Control has recently applied to the State Board for a loan under this program.
To alleviate drainage problems in the dairy area and thereby reduce surface water quality problems which result from dairy waste inputs, the following measures need to be implemented:

1. Riverside Avenue interceptor swale - San Bernardino County and/or the cities of Ontario and Chino should pursue the funding and implementation of the interceptor swale project at Riverside Avenue.

2. Other drainage controls - Both San Bernardino and Riverside counties and the cities tributary to the dairy area should identify and implement a coordinated program of drainage controls necessary to supplement the interceptor swale and prevent drainage problems within the dairy area.

The Counties will be required to implement such best management practices (BMPs) as part of their upcoming NPDES stormwater permits.

DAIRY OPERATIONS OUTSIDE THE CHINO BASIN

This report has focused on dairy operations and water quality problems in the Chino Basin. Since the greatest concentration of dairies occurs in that area, this focus seems appropriate. But it must be remembered that there are established dairies elsewhere in
the Region, specifically, in the San Jacinto Basin. Many new dairies have been established in the San Jacinto Basin in recent years, and this trend appears to be continuing. To prevent the recurrence of the groundwater quality problem now confronting the Region in the Chino Basin, staff believes that an appropriate dairy waste management strategy for the San Jacinto Basin must be developed and implemented. The pattern of dairy land use, the quality of underlying groundwater, the availability of assimilative capacity in the San Jacinto groundwater subbasins should be considered in more detail before recommending a specific strategy. However, it is anticipated that many elements of the strategy recommended for the Chino Basin, particularly those parts which pertain to modifications of Waste Discharge Requirements, would apply also in the San Jacinto Basin. Staff recommends that the Board direct staff to prepare a dairy waste management strategy for the San Jacinto Basin.
APPENDIX A
Salt Loading Unit Factors: Development and Application in the BPP

Since the early 1970's, the Regional Board, in cooperation with the Santa Ana Watershed Planning Agency (SAWPA) (now known as the Santa Ana Watershed Project Authority), has used a water quality-quantity mathematical model called the Basin Planning Procedure (BPP) to estimate the water quality impacts of the dairy industry and other types of land use on the waters of the basin. This modeling procedure is capable of making projections of water quality over time, based on assumptions of future patterns of land use and associated waste loads. The modeling results are used to identify optimal water and wastewater management plans, which are then incorporated in the Basin Plan. The Plan is implemented through the regulatory requirements of the Board and through the participation of interested agencies, such as SAWPA, in implementing programs and facilities found necessary to protect water quality (e.g., the financing and construction of physical facilities such as desalters).

Model Operations: Unit Factors

The BPP calculates waste loads and water demands by multiplying land use acreages in various categories by specific values, known as unit factors. 23 different land uses are identified in the model: six agricultural uses, two industrial uses, nine urban-commercial uses inside the house, and six urban-commercial uses outside the house (Table A-1). Each of these has been assigned a unit factor value for 1) water demand, 2) consumptive use, and 3) salt added to the groundwater (Table A-1: 1a, 1b, 1c, respectively). The salt loading unit factor for a given land use represents the mass loading of salt (expressed as tons/acre/year) that will be transported through the unsaturated surface soil and enter into the underlying groundwater as a result of that land use. An example of the waste load calculation for dairies is as follows. Assuming that there are 640 acres of dairy land and that the salt loading unit factor for dairies is 2.4 tons/acre/year, the daily waste load would be:

\[ 640 \text{ acres} \times 2.4 \text{ tons salt/acre/year} = 1536 \text{ tons salt/year} \]

The modeling process starts with a baseline table of unit factors. Table A-1 shows the values used in the development of the 1983 Basin Plan (Alternative III). Any of these unit factors can be changed, if appropriate, at five year intervals through the planning period being modeled. The unit factors can also vary spatially, i.e., the unit factors for a specific land use type can vary from one area of the Region to another. These changes in unit factors can reflect changes in waste management practices and

A-1

000516 4517
### Table A-1

**BASIN PLANNING PROCEDURE**

**General Table of Unit Factors for the 1983 Basin Plan (Alternative III Model Run)**

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Unit Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture</strong></td>
<td></td>
</tr>
<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
<td>3.4</td>
</tr>
<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td>2.8</td>
</tr>
<tr>
<td>3. Irrigated Orchards</td>
<td>2.6</td>
</tr>
<tr>
<td>4. Vineyards</td>
<td>0.6</td>
</tr>
<tr>
<td>5. Dairies, Feedlots, Poultry</td>
<td>0.84</td>
</tr>
<tr>
<td>6. Other Agriculture</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td></td>
</tr>
<tr>
<td>7. Light Industry</td>
<td>1.35</td>
</tr>
<tr>
<td>8. Heavy Industry</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Urban-Commercial (Inside Use)</strong></td>
<td></td>
</tr>
<tr>
<td>9. Single Family Residential</td>
<td>90.0 gpcd</td>
</tr>
<tr>
<td>10. Multiple Family Residential</td>
<td>95.0 gpcd</td>
</tr>
<tr>
<td>11. Regional &amp; General Commercial</td>
<td>1.2</td>
</tr>
<tr>
<td>12. Commercial Strip</td>
<td>1.0</td>
</tr>
<tr>
<td>13. Neighborhood Shopping Centers</td>
<td>1.2</td>
</tr>
<tr>
<td>14. Public &amp; Institutional Facilities</td>
<td>80.0 gpcd</td>
</tr>
<tr>
<td>15. Schools</td>
<td>1.0</td>
</tr>
<tr>
<td>16. Transportation/Communication (Airports)</td>
<td>0.0</td>
</tr>
<tr>
<td>17. Military</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Urban-Commercial (Outside Use)</strong></td>
<td></td>
</tr>
<tr>
<td>18. Single Family Residential</td>
<td>130.0 gpcd</td>
</tr>
<tr>
<td>19. Multiple Family Residential</td>
<td>90.0 gpcd</td>
</tr>
<tr>
<td>20. Public &amp; Institutional Facilities</td>
<td>0.4</td>
</tr>
<tr>
<td>21. Schools</td>
<td>0.6</td>
</tr>
<tr>
<td>22. Irrigated Greenspace</td>
<td>1.3</td>
</tr>
<tr>
<td>23. Transportation/Communication</td>
<td>0.1</td>
</tr>
</tbody>
</table>
### Table A-1 (cont.)

#### 1B Consumptive Use Unit Factors

**Land Use Category**

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Unit Factor</th>
<th>Percent Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>3. Irrigated Orchards</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>4. Vineyards</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>5. Dairies, Feedlots, Poultry</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>6. Other Agriculture</td>
<td>0.0</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Light Industry</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>8. Heavy Industry</td>
<td>0.50</td>
<td></td>
</tr>
</tbody>
</table>

#### Urban-Commercial (Inside Use)

| 9. Single Family Residential                      | 0.0         |                  |
| 10. Multiple Family Residential                   | 0.0         |                  |
| 11. Regional & General Commercial                 | 0.333       |                  |
| 12. Commercial Strip                              | 0.2         |                  |
| 13. Neighborhood Shopping Centers                | 0.333       |                  |
| 14. Public & Institutional Facilities             | 0.0         |                  |
| 15. Schools                                       | 0.0         |                  |
| 16. Transportation/Communication (Airports)       | 0.0         |                  |
| 17. Military                                      | 0.0         |                  |

#### Urban-Commercial (Outside Use)

| 18. Single Family Residential                      | 0.714       |                  |
| 19. Multiple Family Residential                    | 0.714       |                  |
| 20. Public & Institutional Facilities              | 0.667       |                  |
| 21. Schools                                       | 0.667       |                  |
| 22. Irrigated Greenspace                           | 0.692       |                  |
| 23. Transportation/Communication                   | 0.600       |                  |

#### 1C Salt Added Unit Factors

**Land Use Category**

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Unit Factor</th>
<th>Tons/Acre/Year (or as noted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
<td></td>
<td>0.234</td>
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<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td></td>
<td>0.296</td>
</tr>
<tr>
<td>3. Irrigated Orchards</td>
<td></td>
<td>0.312</td>
</tr>
<tr>
<td>4. Vineyards</td>
<td></td>
<td>0.142</td>
</tr>
<tr>
<td>5. Dairies, Feedlots, Poultry</td>
<td></td>
<td>2.38</td>
</tr>
<tr>
<td>6. Other Agriculture</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Year</td>
<td>TDS</td>
<td>Nitrate</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>1975 Basin Plan</td>
<td>0.59</td>
<td>1</td>
</tr>
<tr>
<td>1983 Basin Plan (Alternative I)</td>
<td>3.38</td>
<td>1</td>
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<tr>
<td>1983 Basin Plan (Alternative II)</td>
<td>2.97</td>
<td>1</td>
</tr>
<tr>
<td>1983 Basin Plan (Alternative III) (Recommended Plan)</td>
<td>2.38</td>
<td>1</td>
</tr>
<tr>
<td>1988 MWD Chino Basin Conjunctive Use Study</td>
<td>5.94</td>
<td>1.205</td>
</tr>
<tr>
<td>1988 Basin Plan Base Plan</td>
<td>2.4</td>
<td>1</td>
</tr>
<tr>
<td>1988 Basin Plan Alternative III</td>
<td>1.75</td>
<td>1</td>
</tr>
<tr>
<td>1989 Nitrogen Study (2.54 (historic))</td>
<td>2.54</td>
<td>0.776</td>
</tr>
</tbody>
</table>

1 BPP calibrated only for TDS through 1988. Model calibration for nitrogen and incorporation of nitrate unit factors are part of 1989 watershed-wide nitrogen study (James M. Montgomery Engineers for SAWPA/SARDA, et al).
The differences among the unit factors shown in Table A-2 are related to actual or assumed dairy waste management practices and the amount of salt thereby removed from the dairy area. The 1975 Basin Plan unit factor was based on the assumption that all wash water would be removed from the dairy area and that all but 10% of the manure generated would be exported (i.e., 90% removal of all dairy salt). The other unit factors reflect different information regarding wash water and manure disposal. As discussed in the main body of this report, wash water removal through sewerage (or any other means) has not been accomplished. Therefore, the unit factors used from 1983 and later include the salt associated with wash water disposal on pasture and cropland in the dairy area. These later unit factors also reflect different assumptions or estimates (based on dairy annual reports) of the amount of manure removed from the area. For the 1988 Basin Plan update baseline run (Base Plan), for example, information from the 1987 dairy annual reports indicated that only 50% of the manure generated in the dairy area was removed. This translated to a salt loading factor of 2.4 tons/acre/year (Table A-3). The water quality effects of a proposed alternative plan were also evaluated (Alternative III (1988)); the dairy salt unit factor assumed therein for planning purposes was 1.75 Tons/Ac/Year. Clearly, this lower unit factor implies that more manure was removed from the area. Note that greater manure removal could theoretically be achieved through greater compliance with the Board’s existing manure disposal requirement (3 Tons/Ac/Year) or through the adoption of (and full compliance with) a more stringent manure disposal requirement. This illustrates how the EPP can be used to assess the water quality impacts of changes in the nature and/or implementation of the Board’s requirements.
Table A-3
1988 Base Plan Dairy Salt Unit Factor

Calculation of 1988 Base Plan (Upper Santa Ana Basin Plan Update) dairy salt unit factor:

a. 4.061 tons salt/acre/year = total unregulated salt loading to groundwater from dairy operations (Webb, 1974, Table 12; 15 cows/acre assumed)

b. 50% removal of dairy manure (see calculation below):
   \[ 4.061 \times 0.50 = 2.0305 \text{ tons salt/acre/year} \]

c. no wash water removal; wash water applied to dairy land; wash water contains approx. 10% of the total dairy waste salt load (Webb, 1974):
   \[ 4.061 \times 0.10 = 0.4061 \]

d. total dairy salt load to groundwater:
   \[ 2.0305 + 0.4061 = 2.436 (2.4) \text{ tons/acre/year} \]

Calculation of % manure removal: (data from annual dairy compliance report to the Regional Board (4-10-87))

Manure produced: \[ 448,500 \text{ tons (dry weight)} \]

Manure reported hauled: \[ 362,000 \text{ tons} \]

fate of manure hauled is unknown: assume that 1/2 of 362,000 hauled is removed from Basin = \[ 181,000 \text{ tons} \]

manure reported used on cropland: \[ 57,400 \text{ tons} \]

\[
\begin{align*}
448,500 & - 181,000 \\
267,500 & - 57,400 \\
210,100 & \text{ tons}
\end{align*}
\]

\[ 210,100 / 448,500 = 0.47 \text{ or } -50\% \]

Note: For the 1988 year (March 10, 1989 report) the manure removal value came to about 55%.
A point which was made earlier in this report should be reemphasized here. That is that these salt loading unit factors for dairy operations are estimates. The information which is available concerning manure removal from the dairy area comes almost exclusively from the dairy annual reports submitted by the dairy operators. It must be emphasized that this information is neither detailed nor necessarily accurate and is not adequate to provide a true picture of the actual fate of all the manure generated. An improved manure tracking system is definitely necessary for this purpose. Further, we do not consider our understanding of the fate of salts applied to surface soils via dairy waste disposal to be definitive. A comprehensive groundwater monitoring program is necessary to provide actual data on the impacts of dairy operations. The information presented by Webb (1974) regarding salt loading rates from dairy operations to groundwater is widely accepted as the best available at the present time. But it is possible that monitoring data and more refined modeling techniques would suggest that modifications of the salt unit factors, for dairies and other types of land use, would be appropriate.

Nondairy Agricultural Salt Unit Factors

Nondairy agricultural salt loading unit factors were developed by in the early 1970's for use in the BPP (WRE, 1970). Since precise records of crop types and fertilizers for agricultural lands within the Region did not exist, unit salt loading factors were estimated by formulating a regional fertilizer mix on a weighted average basis, with common fertilizers used within the Region. This mix is presented below:

Table A-4

<table>
<thead>
<tr>
<th>Fertilizer Type</th>
<th>Relative Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea, Anhydrous Ammonia</td>
<td>60%</td>
</tr>
<tr>
<td>Calcium Nitrate</td>
<td>10%</td>
</tr>
<tr>
<td>Ammonium Sulfate</td>
<td>10%</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>20%</td>
</tr>
</tbody>
</table>

(WRE, 1970)
A fertilizer mix weighted by relative use consists of the following weights of anions and cation per 100 lbs. of total nitrogen:

<table>
<thead>
<tr>
<th>Cations</th>
<th>Weight (lbs.)</th>
<th>Anions</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>Cl</td>
<td>8</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>SO₄</td>
<td>45</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>NO₃</td>
<td>359</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>PO₄</td>
<td>14</td>
</tr>
</tbody>
</table>

Note that direct conversion of 100 lbs. of nitrogen to nitrate (NO₃) is 443 lbs. However, Table A-5 lists only 359 lbs. of nitrate for every 100 lbs. of total nitrogen. The reduction from 443 to 359 lbs. is attributable to the assumed volatilization of nitrogen in the form of ammonia and the fixation (uptake) of nitrogen by soil microorganisms (WRE, 1970).

When the regional fertilizer mix is applied to the agricultural soil, crop uptake, volatilization, soil microorganism fixation, and a number of geochemical reactions occur which effectively reduce the amount of salt contained in the fertilizer from leaching to the underlying ground water aquifer. Volatilization and fixation of nitrogen have already been taken into account. Crops will utilize nitrate (NO₃) and ammonium (NH₄), potassium (K), and phosphate (PO₄). Cations will adsorb to and desorb from negatively charged soil particles which constitutes a process known as ion exchange. Available phosphorous may also react with calcium to form a relatively insoluble product, calcium phosphate, which is immobile in the soil. Calcium (Ca) and magnesium (Mg) will react with bicarbonate (HCO₃⁻) in the irrigation water to also form relatively insoluble salts. The anions chloride (Cl), sulfate (SO₄²⁻), and nitrate (NO₃) will move readily with the soil water and associate with the most predominant cation, which is also transported through the soil. Since the soils in the Chino Basin dairy area are reported to be rich in calcium, this cation was assumed by WRE (1970) to be transported with the mobile nitrate or sulfate. However, sodium was assumed to be associated with the chloride moving through the soil, which does not result in a significant difference in the total salt unit load factor.
By applying the regional fertilizer mix to similar crop types at application rates developed through consultation with local farm advisors, the salt contribution to ground water was estimated by WRE (1970). As an example of the detailed computations required for the formulation of each loading factor, the specific case for irrigated citrus was considered by staff, using WRE's methodology.

Table A-5

<table>
<thead>
<tr>
<th>Ion</th>
<th>Weight Per 100 lbs N (lbs.)</th>
<th>Weight Per 100 lbs N (lbs.)</th>
<th>Crop Uptake (lbs.)</th>
<th>Leaching (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>202</td>
<td>--</td>
<td>124[Ca(NO₃)₂]</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>23</td>
<td>--</td>
<td>32[Ca(SO₄)₂]</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>37</td>
<td>37</td>
<td>--</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>8 [NaCl]</td>
</tr>
<tr>
<td>Cl</td>
<td>8</td>
<td>13</td>
<td>--</td>
<td>13</td>
</tr>
<tr>
<td>SO₄</td>
<td>45</td>
<td>72</td>
<td>--</td>
<td>72</td>
</tr>
<tr>
<td>NO₃</td>
<td>359</td>
<td>574</td>
<td>186</td>
<td>388</td>
</tr>
<tr>
<td>PO₄</td>
<td>14</td>
<td>22</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Total Salt: 637 lbs. (0.318 tons)

Thus, 0.318 tons of salt/acre/year was estimated by staff to be contributed to the ground water from the application of the regional fertilizer mix from citrus agriculture. This value is reasonably consistent with the unit factor reported by WRE (1970) of 0.312. The reason for the difference is unknown, but might be the result of round-off error or slight differences in the fertilizer application rate or crop uptake rates, which were reported by Hassan (1969).
The nondairy agricultural salt unit factors developed by WRE have been used in BPP work with only minor modifications since the early 1970's. However, some of these unit factors were recently updated through the calibration of the BPP in work performed by James M. Montgomery Engineers (JMM, 1989) as part of the watershed-wide nitrogen study. Unit factors for nitrate as well as TDS have also been developed by JMM for these nondairy agricultural land uses. An historical listing of the unit factors for nondairy agricultural land use is shown below:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated Pasture + Field Crops</td>
<td>0.234</td>
<td>0.234</td>
<td>0.23 0.146</td>
</tr>
<tr>
<td>Irrigated Row + Truck Crops</td>
<td>0.296</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Irrigated Orchards</td>
<td>0.312</td>
<td>0.312</td>
<td>0.21 0.0</td>
</tr>
<tr>
<td>Vineyards</td>
<td>0.142</td>
<td>0.142</td>
<td>0.142 0.080</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Non Irrigated Hay and Pasture,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Crops</td>
<td></td>
<td></td>
<td>0.23 0.146</td>
</tr>
</tbody>
</table>

Model calibrated only for TDS; no nitrate unit factors.

Model Evaluation of Salt Leaching from Fertilizers

Nondairy agricultural salt unit factors have been considered even more recently by Regional Board staff (as a part of the preparation of this report). In order to evaluate the amount of salt leaching from various fertilizers to the ground water, Regional Board staff employed a computer model developed by the U.S. Salinity Laboratory. The model simulates the steady-state transport of specific ions which comprise the salts in fertilizers. Essentially the same methodology that was used by UCCC (1973) was employed.
during this analysis. These comparisons were made to provide general insight into the relative amounts of salt contained in fertilizer that leach beyond the plant root zone and enter the underlying ground water. Simulations which consider all factors which will effect salt transport in soil, such as, soil composition and stratigraphy or the addition of soil amendments were not considered in this evaluation.

The computer model developed by the Salinity Laboratory is commonly used to evaluate the suitability of water for irrigation use. The model simulates the concentration (meg/l) of predominant anions and cations in the soil water within the plant root zone. Not all of the salt that is applied to land from fertilizer or irrigation water will leach to the ground water table. Plants will take up significant amounts of nitrogen and to a much smaller degree some of the other salts. Some of the other salts in the soil water will also precipitate to form relatively insoluble compounds that remain in the soil. Thus, only about one-half of the salts originally applied to the soil will actually be transported to the ground water, but the actual amount depends on factors considered in the model, which include the irrigation leaching fraction, the partial pressure of CO₂, and the specific ion characteristics of the irrigation water and applied fertilizer, and the ionic strength of the soil water solution.

The Salinity Laboratory model does not account for plant uptake or the presence of phosphate in the applied water. Thus, a computer program (prepwats.m) was developed by staff to consider these factors before the Salinity Laboratory model (watsuit.for) could be employed. Staff used the same rationale employed by UCCC (1973). A second computer program (convwats.m) was also formulated by staff to convert the results produced by the Salinity Laboratory model into unit loading rates (tons/acre/year) commonly used in the Santa Ana Basin computer model. All of the computer programs employed for these evaluations are included in this Appendix.

The results of these simulations are described in Section III-D.

1(Presented in Tables 4-10 and 4-11 of this staff report).
APPENDIX B

Calculation of the 3 ton(dry)/acres/year Manure Disposal Requirement

Using data generated by UCCC (1973a) and UCCC (1973b), Regional Board staff developed a regression curve for the relationship between the amount of salt applied to agricultural land in manure and the mass of salt which will migrate to groundwater. The form of the regression curve is:

\[ y = ax^b \]

where:

- \( y \) = the mass of salt per acre transported to the ground water.  
- \( x \) = the mass of salt per acre applied to the agricultural land in the manure. 

\( a = 0.34988 \)
\( b = 1.06473 \)

The regression coefficient for this curve fit was 0.99933, where a value of 1.00 represents a perfect fit of the regression curve with the data.

The calculations substantiating the 3 ton dry manure/acre/year application limit uses this regression curve. These calculations are presented below:

Allowable amount of salt that may be applied:

\[ (0.30/0.34988)^{1/1.0647} = 0.86 \text{ tons of salt/acre/year} \]

Allowable dry weight of manure that is equivalent to the 0.86 tons/acre loading rate is:

\[ \frac{0.86 \text{ tons salt}}{\text{acre}} \times \frac{1 \text{ ton manure}}{0.2873 \text{ tons salt}} = 3.01 \text{ tons dry manure/acre year} \]
Memorandum

September 26, 1989

To: California Regional Water Quality Control Board
   Santa Ana Region
   6809 Indiana Avenue, Suite 200
   Riverside, CA 92506
   Attention: Joanne Schneider
            Environmental Program Manager

From: Department of Water Resources
       Los Angeles, CA 90055

Subject: Order No. 89-131, Waste Discharge Requirements for J. B. Aquerre, dba J. B.'s Calves, Chino, San Bernardino County

We appreciate the opportunity to review and comment on the subject discharge.

In support of your requirements to protect the local water resources we recommend that the discharger, J.B.'s Calves, be required to submit the following to your Executive Officer for evaluation and approval:

1. A site specific engineering plan to retain all dairy waste water within the dairy including the precipitation and drainage through manured areas which can result from rain in a 24-hour period in a 25 year, 24-hour storm; and,

2. A site specific engineering plan to divert surface flow to prevent inundation of the disposal and manured areas by runoff that could result from a 24-hour, 100 year frequency storm.

And we recommend that this order stipulate that manure removed from the dairy for offsite disposal be hauled only to sites previously approved by the Board to accept dairy waste.

We also recommend that the underlined be added to requirement No. 3 in the Reporting Program.

3. All reports shall be signed and submitted by a principal executive officer or equivalent or his/her authorized representative under penalty of perjury.

If you have any questions concerning our comments, you may wish to contact Harry Iwanaga of my staff at (213) 620-4836.

Herry Iwanaga

Ahmad A. Hassan, Ph.D., Chief
Resources Inventory Branch

APPENDIX D

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000529
Appendix E

SAMPLE MANURE TRACKING MANIFEST

This form must be completed for each day and each location where manure is transported. All information provided on this form is submitted under penalty of perjury.

Operator’s Name: ____________________________________________
Facility Name: ______________________________________________
Facility Address: ____________________________________________
Mailing Address: ____________________________________________

Hauler’s Name: ______________________________________________
Amount Hauled: _______ Tons   Date Hauled: ____________
Hauled to: (address, Township/Range coordinates, or nearest major cross street)

Hauler’s Signature: __________________________________________
Date: __________________________

Owner/Responsible Party of Final Destination Point: (print or type)

Owner’s/ R.P.’s Signature: _____________________________________
Date: ________________________

This form must be returned to the animal confinement facility operator upon completion.

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000530
APPENDIX F

ITEMS THAT SHOULD BE INCLUDED IN ENGINEERED WASTE MANAGEMENT PLANS

The following information shall be submitted as an attachment to Reports of Waste Discharge for all animal-confinement facilities. The waste management plan shall be developed by a registered professional engineer, a member of the West End Resource Conservation District, a member of the Soil Conservation Service, or other qualified persons, as approved by the Executive Officer.

SITE PLAN REQUIREMENTS

The Site Plan shall include:

1. Assessor parcel number(s), address and/or legal description of the facility.

2. Name, address, and telephone number of the owner and operator of the proposed facility.

3. The total gross acreage of property, showing all existing and/or proposed facilities [including buildings, storage areas, berms, holding ponds, well sites, pumping facilities, storm water conveyance facilities, culverts, drainage easements, disposal area(s), cropland (whether farmed by the owner/operator or another party), etc]. Include the overall dimensions, north arrow, date the plan was developed, and scale. The site plan shall be submitted at an appropriate scale that shows sufficient detail of the proposed facility and all site operations including all disposal areas and wastewater containment structures. A recommended scale would be 1" = 50'. The plan should be drawn on standard 17 X 36 blue print format.

4. Containment facilities shall be designed to retain on the property all dairy wastewater and stormwater runoff due to precipitation on and drainage through manured areas which results from any one storm event up to and including a 25-year, 24-hour storm event. All manured areas shall be protected from inundation resulting from a 100 year frequency storm. The site plan shall show all facilities necessary for containment and management of all storm water flows onsite as well as the interception
and conveyance of any offsite storm water flows through the proposed site.

7. The site plan shall show the size, elevations, and location of all facilities proposed for containment of wastewater and storm water flows on the site (berms, holding ponds, upstream diversion structures, etc.). Cutaway details of these structures shall be shown.

8. A description of all of the existing and proposed disposal areas for washwater shall be provided. This description should include all disposal areas and/or cropland designated to receive dairy wastes.

DESIGN CALCULATIONS

Design calculations shall include:

1. The volume of dairy washwater generated.

2. A determination of the amount of rainfall that will result from a 24-hour, 25-year storm event.

3. The total amount of water that will need to be contained onsite (washwater + stormwater).

4. The volume of upstream flows that will need to be diverted from manured areas from 100 year storm events (a description of the methodology used to determine the volume of the 100 year storm event should also be included).

5. Percolation rates used in determining wastewater management.

CONSTRUCTION SPECIFICATIONS

Construction Specifications shall include:

1. The construction material to be used and the method of compaction of all berms and/or other containment structures.

OPERATIONS PLAN

The Operations Plan shall include:

1. A proposed rodent control program.
2. A proposed pond management program (this program should be directed to providing maximum capacity prior to winter storms, periodic dredging, etc.)

3. A proposed wastewater distribution program (rotation of fields/areas receiving wastewater, etc.)
REFERENCES


California Regional Water Quality Control Board, Santa Ana Region, 1975, "Water Quality Control Plan, Santa Ana River Basin (8)".

California Regional Water Quality Control Board, Santa Ana Region, 1983, "Water Quality Control Plan Report, Santa Ana River Basin (8)".


Meyer, J. L., R. S. Rauschkolb, and E. Olson, (no date) Published?, "Dairy Manure Utilization and Field Application Rates."
Pratt, P. F., 1984a, "Nitrogen use and nitrate leaching in irrigated agriculture", in Nitrogen in Crop Production, Madison, WI.


Santa Ana Watershed Project Authority, 1990, "Chino Basin Desalter Feasibility Study", Camp Dresser & McKee


State Water Resources Control Board, 1975, "Water Quality Control Plan Report, Santa Ana River Basin (8), Regional Water Quality Control Board Santa Ana Region (8).


University of California Water Quality Task Force, Committee of Consultants (UCCC), 1973a, "Supporting data, salt and nitrate excreted by various livestock", March 7 memorandum.

Lagoon Seepage and Mass Loading of Pollutants

Calculations for the Borba Dairy, Kern County, California
Prepared for the Protestants of the Borba Dairy
July 20, 2000

The following calculations were performed by Kathy J. Martin, PE of Martin Environmental Services, Norman, Oklahoma at the request of counsel for the Protestants of the Borba Dairy. Ms. Martin has a Master’s Degree in Civil Engineering from the University of Oklahoma (1989) and is a licensed professional engineer in Oklahoma for Civil Engineering. Her resume is attached and includes work experience in the field of environmental permitting for industrial wastewater. She drafted the rules and regulations used by the State of Oklahoma since 1990 to regulate surface impoundments and land application as they relate to facilities that generate non-hazardous industrial wastewater. In addition, Ms. Martin has been working on CAFO related issues full-time since 1997 including CAFO permitting processes in Oklahoma, Kansas, Nebraska, Utah, Missouri, Arkansas, Iowa, and Wyoming. She has performed technical and regulatory reviews of permit applications for over 45 different CAFO facilities, including large-scale swine operations, liquid manure dairy systems, and related wastewater treatment systems used by poultry slaughtering facilities in West Virginia (i.e., surface impoundments and land application). She is familiar with the federal and state regulations governing CAFOs, as well as the Clean Water Act and Water Quality Standards.

Volume of Seepage from Lagoons:
According to the application, there are 19.5 acres of lagoons per dairy "site". The lagoons are designed to have a seepage rate of \(1 \times 10^{-5}\) cm/sec, which is equivalent to 9236 gal/acre/day seepage:

\[
1 \times 10^{-5} \text{ cm/sec (in/2.54 cm)(gal/231 in}^3 \text{)(3600 sec/hr)(24 hr/day)(144in}^2/\text{ft}^2(43560 \text{ ft}^2/\text{acre})
\]

The seepage rate is reported in volume per unit area, which is a rate of flow of wastewater through the saturated liner of the lagoon. According to the September 3, 1999 report to Kern County, Borba intends to construct the lagoons according to NRCS guidelines and will attempt to achieve this seepage rate. There are two types of seepage in lagoons -- vertical seepage along the bottom of the lagoon and a combination of vertical and horizontal seepage at the berms. One method to estimate seepage from a lagoon given minimal design information is to use the surface area at maximum liquid depth as an estimation of both vertical and horizontal seepage. Considering that horizontal seepage is much higher than vertical seepage when using a properly compacted clay liner, this broad method of estimation is conservative in that it can overestimate seepage due to only vertical...
paths on the bottom of the lagoon (ie., a smaller surface area of flow). However, when attempting to protect groundwater, it is prudent to overestimate seepage rather than underestimate seepage. The seepage calculation does not include losses due to failure of the lagoon, which will be termed leakage in this report. This seepage can be compared to the surface area of the lagoons at each site:

9236 gal/acre/day x 19.5 acres x 365 d/yr = 65.7 million gallons per year per facility

65.7 million gallons x 2 facilities = 131.47 million gallons per year

Mass Loading in Seepage
The mass loading of pollutants in the seepage can be calculated using average concentrations of salts as found in lagoon wastewater reported in "Seepage Rates and Ground Water Quality Impacts from Manure-Lined Dairy Waste Lagoons" published by the Environmental Improvement Division, Ground Water and Hazardous Waste Branch of the New Mexico Health and Environment Department (late 1980's).

Average values for total dissolved solids, bicarbonates, chlorides, sodium, ammonia, and total nitrogen were calculated using the following values from the report:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TDS (ppm)</th>
<th>Bicarb (ppm)</th>
<th>Ammonia (ppm)</th>
<th>TKN (ppm)</th>
<th>Chlorides (ppm)</th>
<th>Sodium (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>663</td>
<td>22.2</td>
<td>75.3</td>
<td>123.6</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>1295</td>
<td>1051.5</td>
<td>83.4</td>
<td>131</td>
<td>153.9</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>5052</td>
<td>1978</td>
<td>73.7</td>
<td>87.2</td>
<td>910</td>
<td>449</td>
<td></td>
</tr>
<tr>
<td>2869</td>
<td>1649</td>
<td>27.2</td>
<td>194</td>
<td>448</td>
<td>191</td>
<td></td>
</tr>
<tr>
<td>2630</td>
<td>1565</td>
<td>219</td>
<td>257</td>
<td>706</td>
<td>435</td>
<td></td>
</tr>
<tr>
<td>2280</td>
<td>1391</td>
<td>164</td>
<td>285</td>
<td>773</td>
<td>476</td>
<td></td>
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<tr>
<td>3412</td>
<td>85</td>
<td>183</td>
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<td>81</td>
<td>152</td>
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<tr>
<td></td>
<td>83.9</td>
<td>118</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>174.8</td>
<td>128.9</td>
<td></td>
<td></td>
<td>198</td>
<td></td>
</tr>
</tbody>
</table>
Mass loading is calculated using the annual volume of seepage (million gallons/year) multiplied by the concentration (ppm) and a conversion factor (8.34 lbs/million gallons):

**Total Dissolved Solids calculated at 681 tons per year per facility:**
\[
60.68 \text{ mil gal/yr} \times 2691 \text{ ppm} \times 8.34 \text{ lbs/mil gal} = 1,361,837.5 \text{ lbs TDS/yr}
\]

**Bicarbonate salts calculated at 350 tons per year per facility:**
\[
60.68 \text{ mil gal/yr} \times 1383 \text{ ppm} \times 8.34 \text{ lbs/mil gal} = 699,896 \text{ lbs Bicarb/yr}
\]

**Chloride salts calculated at 131 tons per year per facility:**
\[
60.68 \text{ mil gal/yr} \times 519 \text{ ppm} \times 8.34 \text{ lbs/mil gal} = 262,650 \text{ lbs Na/yr}
\]

**Sodium salts calculated at 78 tons per year per facility:**
\[
60.68 \text{ mil gal/yr} \times 308 \text{ ppm} \times 8.34 \text{ lbs/mil gal} = 155,869 \text{ lbs Cl/yr}
\]

**Total nitrogen compounds at 41 tons per year per facility:**
\[
60.68 \text{ mil gal/yr} \times 164 \text{ ppm} \times 8.34 \text{ lbs/mil gal} = 82,995 \text{ lbs TKN/yr}
\]

**Summary of mass loading is provided in the following table:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lbs/yr</th>
<th>tons/yr</th>
<th>lbs/design</th>
<th>tons/design</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>1,361,837.5</td>
<td>681</td>
<td>27,236,750</td>
<td>13,618</td>
</tr>
<tr>
<td>Bicarb</td>
<td>699,896</td>
<td>350</td>
<td>13,997,920</td>
<td>6,999</td>
</tr>
<tr>
<td>Chlorides</td>
<td>262,650</td>
<td>131</td>
<td>5,253,000</td>
<td>2,626</td>
</tr>
<tr>
<td>Sodium</td>
<td>155,869</td>
<td>78</td>
<td>3,117,380</td>
<td>1,559</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>82,995</td>
<td>41</td>
<td>1,659,912</td>
<td>830</td>
</tr>
</tbody>
</table>

**Combined Mass Loading -- Both Dairy Facilities**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lbs/yr</th>
<th>tons/yr</th>
<th>lbs/design</th>
<th>tons/design</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>2,723,675</td>
<td>1,362</td>
<td>54,473,500</td>
<td>27,237</td>
</tr>
<tr>
<td>Bicarb</td>
<td>1,399,792</td>
<td>700</td>
<td>27,995,840</td>
<td>13,998</td>
</tr>
</tbody>
</table>

Seepage Calculations and Mass Loading of Borba Dairy Facilities
Page 3
Prepared by Kathy J. Martin, PE, Martin Environmental Services, Norman, Oklahoma July 20, 2000
| Chlorides | 525,300 | 263 | 10,506,000 | 5,253 |
| Sodium     | 311,738 | 156 | 6,234,760  | 3,117 |
| Total Nitrogen | 165,990 | 83  | 3,319,800  | 1,660 |

These estimates of seepage do not include the seepage losses from the barns nor from the solids separation trenches located hydraulically prior to the waste lagoons. Therefore, the total seepage from this facility would be more than that indicated in the tables. It is important to note that whatever losses that do not occur from the lagoon(s) represent a volume of wastewater that must still be disposed of by land application. The mass loading of pollutants on the aquifer includes not only the mass loading in the allowable seepage from each lagoon at each facility, but also the mass loading due to disposal by land application for both facilities. That additional mass loading was not calculated in this report, but it is highly recommended that more study be made to determine the total loading on the aquifer system for nitrogen compounds and especially for total dissolved solids (salts).

Environmental Concerns
The Agency must evaluate the mass loading of these salts on the unconfined groundwater aquifer that is located beneath the facilities. This groundwater is already known to be contained with little or no egress, which causes salts to accumulate in the groundwater basin. The allowable seepage is extremely high as compared to that allowed for municipal lagoons (typically 500 gallons per acre per day). The seepage for the very concentrated dairy wastewater is more than 18 times that allowed for the more dilute domestic sanitary wastewater.

The EIR indicates more shallow groundwater systems than those admitted to at depths of 130 feet. The report includes reference to a sand layer underlain by a thick clay layer at the facility. This sand/clay interface apparently occurs at depths of 40 feet. A sand layer underlain by clay, albeit Intermittent in this region, is considered by most hydrogeologists to be a "perched" aquifer. The perched aquifer may not accumulate enough water to be a "producing" aquifer, but it can be considered waters of the state and protected as such. The perched water can and will interact with underlying aquifers at the point of saturation of the intervening clay layer, or sooner with the horizontal movement of the perched water to the edge of the clay layer. This phenomena allows wastewater to travel laterally beyond the expected boundary of the lagoon. In other words, the wastewater will not just seep straight down to the aquifer, but may travel in a lateral direction dictated by the slope of the intervening clay layer and enter the underlying aquifer materials at some point different than that of the lagoon. Monitoring wells should be set up to detect this movement.

The use of existing water wells as the groundwater monitoring for this facility is a lax enforcement of groundwater quality standards. The wells built to produce large...
quantities of groundwater are not necessarily built to detect pollution. The non-nitrogen salt pollution will occur at different depths than the more mobile ammonia and nitrate pollution. The nitrogen pollution is proposed to be detected by "nitrates" instead of ammonia and nitrates. It is well known that ammonia and nitrate levels in the groundwater will be inversely proportional as the microbial community transforms dissolved ammonia into nitrite and nitrate. Therefore, the lack of detection of nitrates is not a proof-positive indicator of no pollution. The testing must include more conservative pollution parameters, such as chlorides, bicarbonates, and sodium in addition to ammonia, nitrates, and total nitrogen.

This report was prepared by Kathy J. Martin, PE in Norman, Oklahoma
Signature: 
Date: 
Seal: Oklahoma PE #18254
Jane L. Mawdley · Alison E. Brooks · Roger J. Merry

Movement of the protozoan pathogen Cryptosporidium parvum through three contrasting soil types

Received: 1 June 1994

Abstract The potential for transfer of the protozoan pathogen Cryptosporidium parvum through soil to land drains and, subsequently, water courses following the application of livestock waste to land was monitored in the laboratory using simulated rainfall and intact soil cores. Following irrigation over a 21-day period, Cryptosporidium parvum oocysts applied to the surface of soil cores (initial inoculum concentration \(1 \times 10^6\) oocysts core \(^{-1}\)) were detected, albeit in low numbers, in the leachates from clay loam and silty loam soils but not in that from a loamy sand soil. Variations in leaching patterns were recorded between replicate cores. At the end of the study soil cores were destructively sampled to establish the location of oocysts remaining within the soil. Distribution within cores was similar in all three soil types. The majority (72.8 ± 5.2%) of oocysts were found in the top 2 cm of soil, with numbers decreasing with increasing depth to 13.2 ± 2.8%, 8.39 ± 1.4%, and 5.36 ± 1.4% at depths of 10, 20, and 30 cm, respectively.

Keywords Cryptosporidium parvum · Livestock waste · Pathogens · Oocysts · Soil cores · Drinking water

Introduction

Livestock wastes are considered a pollution threat because of their high biological \(O_2\) demand and their ability to release nitrates and phosphates to the aqueous environment (Khaleel et al. 1980; Kandel and Eder 1993). These wastes also contain large numbers of microorganisms which may include pathogenic species (Elliott and Ellis 1977; Strauch 1987; Kearney et al. 1993) and it is now recognized that following the application of livestock waste to land there is a potential for the transfer of these microorganisms to the human population following contamination of plants, soil, and subsequently, water courses.

In the well developed countries of Western Europe and North America with drinking-water treatment facilities designed essentially for bacterial removal, the incidence of large scale waterborne bacterial gastroenteritis is now rare. However, over the last two decades there has been increasing concern over the emergence of new forms of enteritis caused by protozoan parasites and enteroviruses (West 1991). One such disease is cryptosporidiosis caused by the protozoan parasite Cryptosporidium parvum, and the waterborne transmission of the pathogen is now well documented (Sterling 1990). This organism is of particular concern since as few as 10 infective oocysts may be required to cause infection (Smith 1992) and because its transmissive oocyst is resistant to current methods used in drinking-water treatment (West 1991).

Cryptosporidiosis is not a new disease. Cryptosporidium muris was first described in 1907 and Cryptosporidium parvum, the species responsible for the infection of livestock and man, was classified as long ago as 1912 (Tyzzer 1907, 1912, cited in Fayer et al. 1990). However, the importance of the microorganism as a causative agent of scouring in young cattle was only recognized in the 1970s (Current 1987) and it is only through improvements in detection methods and increases in epidemiological surveillance that an indication of the extent of both human and animal infection has now been realized.

Infection is via the faecal-oral route and occurs following ingestion of the transmissive oocyst (4–6 \(\mu\)m in diameter) which is excreted in large numbers (up to \(1 \times 10^{16}\) g \(^{-1}\)) in the faeces of infected animals (Smith 1992). The severity of the disease is governed by a number of factors including the immunological status of the host. In the human population immunocompromised patients, especially those with AIDS, suffer a severe infection resulting in protracted diarrhoea which is often irreversible, ultimately resulting in death (Grimason et al. 1990). Immunocompetent patients are less severely affected, diarrhoea and abdominal pain being accompanied by a flu-like malaise which generally lasts 7–14 days, although
general feelings of malaise may persist for up to a month (Smith 1992). Excretion of oocysts commences with the onset of diarrhea but may persist long after disease symptoms have ceased (Ungar 1990). In animals, infection is almost exclusive to the young (Robertson and Smith 1992), calves being especially susceptible. In humans, infection may occur at any age although young children are more prone because of their lower hygiene levels (Grimson et al. 1990).

Although many studies have been made of the movement of microbialin soil (Gannon et al. 1991 a, b; Huysman and Verstrate 1993; Paterson et al. 1993) these have largely concentrated on bacteria and, to a lesser extent, viruses and most have been in risk-assessment studies of microbial inoculants. The potential for transfer of microorganisms, particularly protozoa, to water courses, after the application of livestock waste to land has not been addressed to any great extent. The aim of this study was to investigate the transport, with percolating water, of Cryptosporidium parvum oocysts through three different soil types.

**Materials and methods**

Development of methodology for oocyst extraction from soil

Initial studies were undertaken to investigate the efficiency of the method that Campbell et al. (1992) used to extract Cryptosporidium parvum oocysts from faecal samples at removing oocysts from soil. Samples of Denhigh clay loam soil (1 g dry weight equivalent) contained within 30-ml centrifuge tubes were inoculated with 5 x 10^2 oocysts g^-1 and incubated at 20°C for up to 14 days. At intervals replicate samples were removed and oocysts purified according to Campbell et al. (1992).

In subsequent studies attempts were made to improve the recorded recovery efficiencies by using different extraction fluids in combination with a more rigorous physical dispersal technique. Distilled water, phosphate-buffered saline (pH 7.2), 50 mM TRIS (BDH, Poole, UK), 50 mM TRIS + 0.5% (v/v) Tween 80 (BDH, 0.1% (w/v) sodium cholate (Sigma Chemical Co., Poole, UK), and 0.1% (w/v) sodium cholate + imidodiacetic acid chelating resin (Sigma Chemical Co.) were tested as possible extraction solutions. Extraction solution (20 ml) was added to each of three replicate soil samples (as used in the above study) and the contents vortexed for 1 min before centrifugation (10 min, 1500 g; Cemagrum 1 bench centrifuge, MSE, Crawley, UK). The supernatant fraction was discarded and the washing procedure repeated. After the second wash the pellet was resuspended in 10 ml of the extraction solution, 10 glass beads (3 mm diameter) added, and the sample mixed for 15 min on a wrist-action shaker (Stasmar Scientific flask shaker, BDH, Poole, UK). The resulting suspension was underlaid with 10 ml cold sucrose solution (specific gravity 1.18) and centrifuged (15 min, 1500 g). The interface (10 ml) was removed to a clean 30-ml centrifuge tube using a syringe fitted with a 0.8 x 40 mm hypodermic needle (Terumo, Fisons, Loughborough, UK) and washed three times in distilled water. After the final wash the supernatant fraction was removed down to 1 ml, and aliquots were stained and examined microscopically for the presence of oocysts (see below). Samples (20 ml) were dried onto 1-cm^2 areas on microscope slides, fixed in methanol, stained in auramine phenol (Lemper, BDH), counterstained in dilute carbol fuchsin (Gurr, BDH), and allowed to dry (Cascione et al. 1985). Slides were examined using an epifluorescence microscope (BX42, Olympus Optical Company, London, UK) equipped with a blue filter block (excitation 490 nm, emission 510 nm). The number of oocysts in each of 100 randomly chosen fields of view was counted, and at least three replicate slides for each sample were examined. Numbers of oocysts detected were expressed (with SE) as the mean of replicates. Student's t -test was used to assess the difference between sample means.

**Soil columns**

Intact soil cores were taken from each soil type by driving 35-cm lengths of 15 cm (inner diameter) polyvinyl chloride (PVC) drain piping 30 cm into the soil. To aid this process, detachable steel cutting edges were fitted to the bottom of each tube. Three contrasting soil types were used in the study, a loamy sand, a silty loam, and a clay loam; further details of these soils are shown in Table 1. All three soils were taken from perennial ryegrass fields and cores were taken with the vegetation intact. Once extracted, the cores were transported back to the laboratory and brought to maximum water-holding capacity by irrigation over a 5-day period. Five replicate cores were mounted on an irrigation/support apparatus in a constant temperature room (18°C) and Cryptosporidium parvum oocysts (supplied by J. Kemp and S. Wright, Moreton Hayn Research Institute, Edinburgh, UK) were applied to each core at a density of ca. 1 x 10^5 oocysts core^-1. After 16 h, artificial rainwater (Skibber and Creser 1986) was applied to each core over a 4-h period at a rate of 70 ml h^-1 by means of a peristaltic pump. Individual lines were used to ensure even dispersal of the rainwater over the surface of the core and these were suspended at a height of 5 cm above the top of the core by inserting them through a clear plastic disk mounted over the top of the core. Irrigation was subsequently repeated on alternate days over a period of 21 days. Leachate from each core drained, via a plastic funnel, into a 500 ml Winchester bottle, and was collected for 24 h following the start of each irrigation event and subsequently analyzed for the presence of oocysts.

At the end of the 21-day study, cores were destructively sampled and soil removed to determine the location of oocysts remaining within the cores. Soil was taken from the top and bottom of the core (at depths of 1 and 30 cm) before holes (4.5 cm diameter) were drilled through the plastic drain piping at depths of 10 and 20 cm. A soil cover (4.25 cm diameter) inserted through the holes was used to withdraw soil from the whole width of the tube and subsamples of this soil, together with that collected from the top and bottom of the core, were examined individually for the presence of oocysts.

**Extraction and concentration of oocysts from leachate and soil samples**

The volume of leachate collected from replicate cores after each irrigation event was measured (average for all soil types at all irrigation times 217 ml, SEM 2.01 ml) and then transferred to a 300-ml centrifuge tube. Samples were centrifuged (Europa 24 M centrifuge,

### Table 1 Characteristics of the three contrasting soil types used in the soil core studies to investigate the vertical transport of the protozoan Cryptosporidium parvum

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loamy sand</td>
</tr>
<tr>
<td>Soil series</td>
<td>Bridenegore</td>
</tr>
<tr>
<td>pH</td>
<td>6.35</td>
</tr>
<tr>
<td>Sand (%)</td>
<td>79</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>81</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>10</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>3.91</td>
</tr>
</tbody>
</table>
MSE, Crawley, UK) for 15 min at 1500 g and ca. 175 ml of the supernatant fraction was discarded. The pellet was resuspended in the remaining leachate and transferred to a 50-ml centrifuge tube. The samples were centrifuged again for 15 min (this and all subsequent centrifugation steps were carried out using a MSE Centrafuge 1 Bench Centrifuge, 1500 g) and the supernatant fraction discarded, leaving ca. 10 ml leachate and the pellet in the tube. This was resuspended in 20 ml 50 mM TRIS +0.5% Tween 80, mixed by vortexing, and recentrifuged for 10 min. The supernatant fraction (20 ml) was removed, leaving 10 ml and the pellet remaining in the tube; these were vortexed to mix before the resulting suspension was further concentrated by sucrose gradient centrifugation and washed as for soil samples (see above). After the final wash the supernatant fraction was aspirated down to 1 ml.

To extract oocysts from soil, 1 g dry weight equivalents of soil removed from samples taken from each depth of the five replicate soil cores were weighed into 50-ml centrifuge tubes. Each sample was analysed in duplicate. To each tube 50 mM TRIS+0.5% Tween 80 (20 ml) was added and oocysts extracted by the method described above.

Aliquots (20 μl) of oocysts concentrated from leachate or soil were dried (at 37°C) onto 1-cm² areas on microscope slides and stained and examined as detailed above.

Results

The preliminary studies undertaken to evaluate the relevance for soil studies of the technique that Campbell et al. (1992) used to extract oocysts from faecal material showed that modification was needed for use in long-term experimental soil studies. Although 61.6% of the added oocysts were extracted immediately following inoculation, the efficiency of recovery declined rapidly, so that by day 7 only 0.32% of the Cryptosporidium parvum oocysts initially inoculated were detected, and by day 9 numbers were below the level of detection (Table 2).

A more rigorous extraction procedure was developed subsequently and the efficiency of the different extraction solutions evaluated. Soil samples that had been inoculated with 5 × 10⁵ oocysts g⁻¹ were extracted using the different solutions at regular intervals over a 21-day period. Table 3 shows the numbers of oocysts extracted on day 14, which were typical of the pattern of results obtained throughout the study, although by day 21 numbers of oocysts extracted from the sodium chloride and sodium citrate plus chelating resin samples had fallen to below quantifiable limits. Extraction using 50 mM TRIS +0.5% Tween 80 consistently gave significantly higher (P < 0.01) oocyst recoveries and was therefore used in all subsequent investigations.

Once a method had been developed to extract Cryptosporidium parvum oocysts from soil, studies were carried out to investigate the fate of the pathogen following its application to soil. Vertical transport with percolating water of the protozoan was demonstrated in all three soil types although variations in the rate and extent of this movement were measured. Whilst oocysts were detected in the leachate from both the loamy loam and the clay loam cores, none were detected in that from loamy sand cores.

In the silty loam soil (Fig. 1) oocysts were detected in leachate from four of the five replicate cores on one or more sample dates over the complete course of the study. The majority (99.1%) of oocysts were detected in the 5 days immediately following introduction and none were detected after day 9. One of the five replicate cores did not release detectable numbers of oocysts over the entire study period. However, on destructive sampling, this non-release core had a distribution of oocysts identical to that observed in the other four replicates, indicating that the eluted oocysts were probably below quantifiable limits.

In the clay loam soil (Fig. 2) oocysts were detected in the leachate of all five replicate cores for the first 7 days after introduction, but thereafter the effluent of only one core continued to contain oocysts and numbers released remained at a similar level over the rest of the 21-day study.

At the end of the study, soil cores were destructively sampled to determine the distribution of oocysts remaining within the cores. Significantly higher numbers of oocysts were recovered from the silty loam soil than from either the loamy sand or clay loam soils (Fig. 3). However, the distribution of oocysts remaining within the cores was similar in all three soil types. The majority of oocysts were located in the top few centimetres of soil (72.8±5.19% at a depth of 1–2 cm), numbers subsequently decreasing with increasing depth with averages for the three soils being 13.2±2.8%, 8.39±1.4%, and 5.36±1.4% at depths of 10, 20, and 30 cm respectively.

<table>
<thead>
<tr>
<th>Incubation time</th>
<th>Oocysts extracted (×10⁵ g⁻¹ dry weight)</th>
<th>Oocysts extracted (% of initial inoculum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 min</td>
<td>308±28</td>
<td>61.6</td>
</tr>
<tr>
<td>1 h</td>
<td>169±23</td>
<td>33.8</td>
</tr>
<tr>
<td>24 h</td>
<td>21.4±2.9</td>
<td>4.3</td>
</tr>
<tr>
<td>4 days</td>
<td>27.3±2.54</td>
<td>5.4</td>
</tr>
<tr>
<td>7 days</td>
<td>1.39±0.53</td>
<td>0.3</td>
</tr>
<tr>
<td>9 days</td>
<td>BQL</td>
<td>BQL</td>
</tr>
</tbody>
</table>

Table 3: Effect of different extraction solutions on numbers of oocysts recovered from Denbigh clay loam soil 14 days after inoculation with 5 × 10⁵ oocysts g⁻¹ dry weight. Values are mean±SEM; those followed by the same letter are not significantly different (P<0.01).

<table>
<thead>
<tr>
<th>Extraction solution</th>
<th>Oocysts extracted (×10⁵ g⁻¹ dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1% w/v Sodium citrate</td>
<td>3.3±1.40a</td>
</tr>
<tr>
<td>0.1% w/v Sodium citrate plus chelating resin</td>
<td>16.2±2.40b</td>
</tr>
<tr>
<td>50 mM TRIS</td>
<td>30.9±3.51c</td>
</tr>
<tr>
<td>Phosphate-buffered saline (pH 7.2)</td>
<td>28.8±3.30c</td>
</tr>
<tr>
<td>50 mM TRIS +0.5% Tween 80</td>
<td>76.8±8.01d</td>
</tr>
<tr>
<td>Distilled water</td>
<td>31.7±3.78c</td>
</tr>
</tbody>
</table>
Discussion

Many studies have examined the effect of soil type on the movement of both bacteria and viruses in soil, although few, if any, have examined the movement of protozoal cysts. Due to their small size, the major factor influencing movement will be soil structure, filtration, and sedimentation of sites, as well as the presence or absence of bacterial cells. Protozoal cysts are considerably larger than bacterial cells (Cryptosporidium parvum cysts are 4-6 μm in diameter), and as with bacteria, filtration and sedimentation will also play a part in governing the degree of microbial movement (Reddy et al., 1992; Campon et al., 1991; Bilton and Harvey, 1992).

Fig. 1. Leaching pattern of Cryptosporidium parvum cysts from core 3 soil following irrigation on alternate days. The numbers in Fig. 1 were derived from total bacteria (BQL) in each sample. Core 2 and Core 3 represent SEM.

Fig. 2. Leaching pattern of Cryptosporidium parvum cysts from core 3 soil following irrigation on alternate days. The numbers in Fig. 2 were derived from total bacteria (BQL) in each sample. Core 2 and Core 3 represent SEM.

Fig. 3. Numbers of oocysts leached / core

Time after introduction (days) 1 3 5 7 9 11 13 15 17 19 21

Numbers of oocysts leached / core

10^2 10^3 10^4 10^5 10^6

Core 1 Core 2 Core 3 Core 4 Core 5

10^2 10^3 10^4 10^5 10^6

Core 1 Core 2 Core 3 Core 4 Core 5
Fig. 3 Distribution of Cryptosporidium parvum oocysts in cores of silty loam, clay loam, and loamy sand soil 21 days after introduction and irrigation. Cores were originally inoculated with $1 \times 10^8$ oocysts core$^{-1}$. Vertical bars represent SEM. dwt Dry weight

![Graph showing the distribution of Cryptosporidium parvum oocysts in different types of soil over a distance from the point of inoculation.]

- **Teme silty loam**
- **Bridgenorth loamy sand**
- **Denbigh clay loam**

The properties of soils and to the number and size of micro pores (Griffith and Quail 1968; Postma et al. 1989; Tan et al. 1992). Clay and organic matter are the major soil components affecting adsorption of bacteria and viruses because of their large surface areas and their negative charge (Marshall 1971; Reddy et al. 1981).

In our study, transport of Cryptosporidium parvum oocysts through soil and into leachate was greater in a silty loam and a clay loam soil than in a loamy sand soil. A study by Paterson et al. (1993) demonstrated similar results for recoveries of an introduced bacterium, Pseudomonas fluorescens, with greater recoveries in the leachate from intact clay loam soil cores than from either sandy loam or loamy sand soil cores. As the majority of evidence suggests that the degree of adsorption is greater and the size of micro pores is smaller in clay as opposed to sandy soils, our results indicate that factors other than adsorption and micro pore size affected the extent of oocyst movement in the present study. A major difference between our study and those cited above reporting greater movement in coarse sandy soils than in clay soils is that while we used intact soil cores, the other studies were all carried out in disturbed and repacked cores. Although repacked cores provide a homogeneous environment in which to study the effect of individual soil variables on microbial movement (Trevors et al. 1990; Gannon et al. 1991a; van Elsas et al. 1991), intact or undisturbed soil cores are more representative of field conditions (Bentjen et al. 1989).

One of the obvious differences between intact soil cores and those that have been repacked is the lack of natural soil structure and the notable absence of macro pores in the latter. Soil water content and the flow of water through soil are major factors affecting the extent of microbrial transport in soil (Kuikman et al. 1990; Trevors et al. 1990; van Elsas et al. 1991). While the importance of macro pores in water transport through soils has been recognized for many years (Thomas and Phillips 1979), it is only recently that the potential effects on the release of soil chemical pollutants have been considered (White 1985). The rapid flow of water through macro pores, whereby largely bypassing the filtering and adsorptive effects of the soil, may also greatly increase the risk of pathogen transport to groundwater and land drains. This hypothesis is supported by many studies indicating that smaller numbers of bacteria are transported through repacked soil cores than through intact cores where channels and pores have been retained (Smith et al. 1985; van Elsas et al. 1991). The presence of macro pores may explain the large difference observed in the oocyst flow pattern in one of the Denbigh clay loam cores in the present study although, in general, remarkably good agreement was recorded between replicate soil cores.

Although all three soil types had been inoculated with similar numbers of oocysts, significantly higher numbers were recovered from the silty loam soil than from either the loamy sand or the clay loam soils. From the results of preliminary studies (J. Mawdsley, unpublished observations) it is clear that this was not due to increased extraction efficiencies in the silty loam soil compared to those measured in loamy sand or clay loam soils, as oocysts were more easily extracted from the loamy sand than from either the silty loam or the clay loam soil. Greater recoveries from the loamy sand in these preliminary studies were probably due to differences in the adsorptive properties of the soils. The loamy sand soil had significantly lower organic matter and clay contents than either the silty loam or clay loam soil. Both organic matter and clay play
a major role in the adsorption of microbes in soil, due to their large surface area and negative charge, and many studies have shown increased adsorption in soils with high organic matter or clay contents (Guy and Visser 1979; Bashan and Levanony 1988; Huysmans and Verstraete 1993). However, this does not explain the higher recoveries of oocysts from the silty loam cores. Perhaps oocysts in silty loam soils are less prone to predation or are less readily degraded compared to oocysts in clay loam or loamy sand soils. We are at present investigating this phenomenon and studies have already shown differences in the viability of Cryptosporidium parvum oocysts in a loamy sand compared to a clay loam soil (Mawdsley 1994).

The retention of microorganisms within the upper sections of soil cores, as recorded in the present study, has been reported in previous investigations of other microorganisms. Wolin and Cassel (1978) monitored the movement of bacteria and streptomyces conidia in a sandy soil and showed that the majority of microorganisms were retained near the soil surface. Gerba et al. (1975) suggested that straining (i.e., retention) of bacteria at the soil surface is a major factor in determining the extent of bacterial transport, and suggested that as bacteria and other particles are strained out at the soil surface, they will in turn have a filtering effect.

The present study has shown that under the conditions examined, with purified oocysts applied in very high numbers, leaching of the pathogen down through the soil profile does occur although the extent of this is affected by soil type. However, the distances examined in this study are shorter than those required for the pathogen to enter land drains. Further studies are needed for an accurate assessment of the real risk of environmental contamination, as the extent and rate of movement through deeper soil horizons may vary significantly from the movement measured in topsoil. It seems likely that a combination of factors, including a natural filtering effect, predation, and loss of viability, may interact to decrease the risk of further environmental contamination following the contamination of soil with oocysts; further studies are in progress to examine these possibilities.

Acknowledgements This work was funded through a MAFF/SoAID Open Contract, CSA 2054 Protozoan, bacterial and viral pathogens, farm animal waste and water quality protection. We thank S. Wright and J. Kemp at the Moreton Research Institute, Edinburgh, for the supply of Cryptosporidium parvum oocysts, Z. Bukhari and Prof. H. Smith at the Scottish Parasite Diagnostic Laboratory, Glasgow, for instruction on the techniques used in oocyst enumeration, and Drs. B. Pain and M. Theodorou at IGOR for useful advice and discussions.

References


Dairy Feedlot Contributions to Groundwater Contamination
A Preliminary Study in New Mexico

Abstract
Feedlot milk production has increased dramatically in New Mexico in the past decade, along with the potential for groundwater contamination from animal wastes. State statutes require animal feedlots to maintain groundwater-monitoring wells and report water quality analyses quarterly to the New Mexico Water Quality Control Commission. This preliminary study analyzed six years of groundwater quality data from seven dairy feedlots and found elevated levels of nitrate, ammonia, chloride, total Kjeldahl nitrogen, and total dissolved solids. Samples were obtained from groundwater-monitoring wells located around dairy wastewater lagoons that were lined with clay, concrete, or synthetic membranes. Mean nitrate concentrations were significantly higher in groundwater samples taken in the vicinity of lagoons with clay liners. Lagoons with synthetic liners produced the lowest mean groundwater concentrations of ammonia and nitrate. Mean concentrations for all contaminants tended to increase as the size of dairy herds increased. Nitrate was the only groundwater contaminant measured that showed a consistently increasing trend from 1992 to 1997.

Introduction
New Mexico ranks 12th in the nation in amount of milk produced. Growth of this industry has been phenomenal in the last decade—especially in New Mexico. In 1970, milk production in New Mexico totaled 304 million pounds; by 1995 it had increased to 3,623 million pounds (1).

Concern is growing about contamination from dairy feedlots as an environmental point-source pollutant in groundwater. Large dairy herds concentrate organic waste in a relatively small land area. Wastewater from the dairy milking center, including wastes from the milking parlor and wash pens (urine, manure, feed solids, hoof dirt) and from the milk house (bulk tank rinse water and cleaning detergents) can be a threat both to groundwater and to surface water (2). The water use of a 100-cow free-stall operation can range from 100 to 1,000 gallons per day. Wastewater is typically collected in a settling lagoon until conditions are suitable for land application or until the liquid evaporates. Lagoons usually are lined with clay, concrete, or a synthetic material; in some cases they are unlined. The collection of wastewater in a lagoon provides an opportunity to apply best management practices to address environmental contamination.

Many of southern New Mexico's milking operations are located in an established dairy center, called "the dairy belt," which runs along the Rio Grande River to the north and south of the City of Las Cruces in Doña Ana County. The threat of contamination in this dairy belt is significant because the depth to groundwater in the aquifer of the Rio Grande Valley is unusually shallow, ranging from 5 to 25 feet; the alluvial materials are generally permeable and allow relatively rapid movement of contaminants from the surface to the...
### Summary of Contaminant Concentrations for all Dairies and All Wells

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Mean Value (mg/L)</th>
<th>Range (mg/L)</th>
<th>Standard (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>.44</td>
<td>0.01 to 1.44</td>
<td>0.2*</td>
</tr>
<tr>
<td>Chloride</td>
<td>975</td>
<td>60 to 2,820</td>
<td>250**</td>
</tr>
<tr>
<td>Nitrate</td>
<td>17.8</td>
<td>0.10 to 179</td>
<td>10*</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>3,170</td>
<td>67.2 to 6,944</td>
<td>500***</td>
</tr>
<tr>
<td>Total Kjeldahl nitrogen</td>
<td>1.7</td>
<td>0.07 to 16.8</td>
<td>—</td>
</tr>
</tbody>
</table>

*New Mexico Water Quality Standard (6) **National Secondary Drinking Water Regulation (5) *National Primary Drinking Water Regulation (5)

underlying aquifer, and the shallow groundwater serves as a domestic water source (3).

Pursuant to Section 3-104 of the New Mexico Water Quality Control Commission (WQCC) Regulations, all dairies in New Mexico are required to apply for and maintain a groundwater discharge permit for discharge of wastewater generated from milk production activities (4). Wastewater must be handled in accordance with the approved permit, which specifies either that wastewater is to remain on site, or that it may be discharged onto neighboring agricultural lands. Discharge to an existing waterway is not permitted. So that the threat dairy cow feedlots pose to the groundwater can be understood and measured, all dairies in New Mexico are required to establish and maintain monitoring wells around their wastewater lagoons. In addition, feedlot dairies must collect water samples from each monitoring well on a quarterly basis and submit the samples to an independent laboratory for analysis of nitrate, ammonia, total Kjeldahl nitrogen (TKN), chloride, and total dissolved solids (TDS).

The purpose of this preliminary study is twofold:

1. to report on the analysis of groundwater samples that have been collected from dairy feedlot monitoring wells in southern New Mexico and
2. to assess the relative impacts herd sizes and lagoon linings have on groundwater contaminant levels.

### Methods

This study analyzed the results of 313 groundwater samples collected from 26 monitoring wells around seven wastewater lagoons on seven dairies located in southern New Mexico over a 1-year period. Water samples were analyzed for nitrate, ammonia, TKN, chloride, and TDS. All data in this study were obtained from the Groundwater Quality Bureau of the New Mexico Environment Department. Water samples from each dairy previously had been submitted to independent laboratories for analysis of ammonia, nitrate, TKN, chloride, and TDS. Each dairy then reported these data to the state of New Mexico to comply with groundwater discharge permitting requirements. Data were extracted from these reports and entered into SPSS® Version 8.0 for Windows for statistical analysis. Figure 1 indicates the layout of a typical dairy in southern New Mexico, including the relative location of monitoring wells around wastewater lagoons.

### Results

As indicated in Table 1, all mean contaminant levels exceeded water quality standards for nitrate, ammonia, chloride, and TDS at all dairies and all wells (5,6). When organic nitrogen and ammonia nitrogen forms are found together, they are measured as Kjeldahl nitrogen. Free ammonia represents the first product of decomposition of organic matter; thus, appreciable concentrations of free ammonia

---

**Figure 1**

Schematic of Typical Dairy

![Schematic of Typical Dairy](image)
Table 2

<table>
<thead>
<tr>
<th>Lining Type</th>
<th>Nitrate</th>
<th>Ammonia</th>
<th>TKN</th>
<th>Chloride</th>
<th>TDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>28.7</td>
<td>1.78</td>
<td>1046</td>
<td>3319</td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>14.7</td>
<td>1.43</td>
<td>916</td>
<td>3119</td>
<td></td>
</tr>
<tr>
<td>Synthetic</td>
<td>7.2</td>
<td>2.13*</td>
<td>944</td>
<td>3037</td>
<td></td>
</tr>
<tr>
<td>Synthetic</td>
<td>25.0</td>
<td>4.405</td>
<td>1.78</td>
<td>1.42</td>
<td></td>
</tr>
<tr>
<td>Synthetic</td>
<td>1.008</td>
<td>.9130</td>
<td>.176</td>
<td>.2446</td>
<td></td>
</tr>
</tbody>
</table>

Significant difference (HSD) post hoc significant at alpha = .05

The following values may be of real significance in appraising the level of free ammonia content in groundwater:
- low — 0.015 to 0.03 mg/L,
- moderate — 0.03 to 0.10 mg/L, and
- high — 0.10 mg/L or greater.

The treatment of drinking water, the goal is to have a concentration of less than 0.1 mg/L; however, less than 0.5 mg/L is acceptable (7).

A one-way analysis of variance (ANOVA) was performed for each contaminant by type of lagoon lining. Nitrate levels were significantly higher for clay linings. Ammonia levels were significantly lower for synthetic linings. TKN was significantly higher for synthetic linings. No significant effect was found for chloride and TDS concentrations (Table 2).

A one-way ANOVA was performed for each contaminant by the number of cows at each farm. Nitrate, ammonia, chloride, and TDS all varied significantly by feedlot size, with lower contaminant concentrations usually observed at smaller dairy herd sizes. TKN was not significantly affected by herd size (Table 3).

No trends in contaminant concentrations were evident for depth of monitoring well or distance to water. Nitrate was the only ground-water contaminant that exhibited an increasing trend over the sampling period (1992 to 1997), as illustrated in Figure 2. Concentrations of the other contaminants showed no meaningful trends over time, remaining relatively stable. No significant correlation was noted among contaminant concentrations, except chloride and TDS (r= 0.89, p=.000).

Discussion

Despite significant progress in reducing pollution, serious water quality problems persist throughout the country (8). Animal feeding operations (AFOs) can pose a number of risks to water quality and public health, mainly because of the amount of animal manure and wastewater they generate (8). Manure and wastewater from animal feeding operations have the potential to contribute pollutants such as nutrients (e.g., nitrogen, phosphorous), sediment, pathogens, heavy metals, hormones, antibiotics, and ammonia to the environment. Excess nutrients in water can result in or contribute to eutrophication and anoxia (i.e., low levels of dissolved oxygen); in combination with other circumstances, excess nutrients have been associated with outbreaks of microbes such as *Pfiesteria piscicida* (8).

Approximately 450,000 agricultural operations nationwide confine animals (9). U.S. Department of Agriculture (USDA) data indicate that the vast majority of farms with livestock are small. About 85 percent of these farms have fewer than 250 animal units (AUs) (10). An AU is equal to roughly one beef cow, therefore, 1,000 AUs is equal to 1,000 beef cows or an equivalent number of other animals. In 1992, about 6,600 farms had more than 1,000 AUs and were considered to be large operations (8).

The goal of USDA and United States Environmental Protection Agency (U.S. EPA) is for AFO owners and operators to minimize water pollution from confinement facilities by means of land application of manure. To accomplish this goal, a unified strategy has been established as a national performance expectation. All animal feeding operations should develop and implement technically sound and economically feasible comprehensive nutrient management plans (CNMPs) to minimize impacts on water quality and public health (8).

USDA and U.S. EPA agree that the following minimum components should be included in a CNMP:
- feed management,
- manure handling and storage,
- diversion of clean water,
- prevention of waste containment leakage,
- provide adequate storage of dry manure,
- manure treatment,
- management of dead animals,
- land application of manure,
- nutrient balance,
- timing and methods of application,
- land management, and
- adequate record keeping (8).

In southern New Mexico, discharge options for milking-center wastewater include sprinkler application and slow surface irrigation on neighboring agricultural fields. To maximize nitrogen uptake, the effluent is usually applied to a cropping system that involves both cool and warm season crops. New Mexico regulations limit the amount of nitrogen that may be applied to crops. The maximum is 200 pounds of nitrogen per acre per year or the amount that the crop will take up plus 25 percent, whichever is greater. Forage crops grown one year round and harvested regul-
TABLE 3

<table>
<thead>
<tr>
<th>Number of Cows</th>
<th>Nitrates</th>
<th>Ammonia</th>
<th>TKN</th>
<th>Chloride</th>
<th>TDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.2</td>
<td>.46</td>
<td>1.55</td>
<td>59.8*</td>
<td>2.217*</td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>.73</td>
<td>1.37</td>
<td>1.266</td>
<td>4.097</td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>.17*</td>
<td>1.96</td>
<td>1.118</td>
<td>3.487</td>
<td></td>
</tr>
<tr>
<td>49.4*</td>
<td>.52</td>
<td>1.64</td>
<td>1.206</td>
<td>3.637</td>
<td></td>
</tr>
<tr>
<td>25.1</td>
<td>.52</td>
<td>1.51</td>
<td>1.133</td>
<td>3.393</td>
<td></td>
</tr>
<tr>
<td>32.1</td>
<td>1.7</td>
<td>.03</td>
<td>22.3</td>
<td>35.2</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.0000</td>
<td>.480</td>
<td>.0000</td>
<td>.0000</td>
<td></td>
</tr>
</tbody>
</table>

Note: HSD post hoc significant at alpha = .05.

Table data courtesy of New Mexico State University, College of Agriculture and Home Economics.

New Mexico farmers are working with state agencies to develop guidelines that allow each dairy farmer to submit a single discharge plan. This effort is new, and guidelines are not yet finalized. The single discharge plan must comply with the technical discharge plan requirements of New Mexico Water Quality Control Commission Regulations (WQCC), requirements of the National Pollutant Discharge Elimination System general permit for Concentrated Animal Feeding Operations (CAFO), the New Mexico Environment Department (NMED) Policy for Storage and Disposal of Dairy Wastes, and the Water Quality Act (11).

Conclusions

Analysis of data from this study yielded the conclusions listed below. It is important to emphasize that these are preliminary conclusions based on a fairly small study (313 groundwater samples collected from 26 monitoring wells around seven wastewater lagoons on seven dairies over a six-year period).

1. Mean contaminant concentrations exceeded groundwater quality standards for nitrate, ammonia, chloride, and TDS at all dairies and all wells.

2. Mean nitrate levels were significantly higher for clay-lined lagoons. Mean TKN, chloride, and TDS levels were slightly higher for clay linings than for cement or synthetic linings. These results suggest that among the three types of linings, clay linings are the least effective at reducing groundwater contamination.

3. Mean ammonia levels were significantly lower for synthetic linings. Nitrate and TDS levels were slightly lower than for cement and clay lagoon liners. These results suggest that among the three types of linings, synthetic linings are the most effective at reducing groundwater contamination.

4. Nitrate, ammonia, chloride, and TDS levels varied significantly by feedlot size, with smaller contaminant concentrations exhibited for smaller dairy herd sizes. TKN showed no significant variation by dairy herd size.

5. Mean nitrate concentrations increased during the sampling period; all other contaminant concentrations remained relatively stable.

Acknowledgements: The following people reviewed the manuscript and are gratefully acknowledged: Marc Leavitt, chief, New Mexico Groundwater Quality Bureau; Tim Kelley, assistant professor, Illinois State University; Kitty Richards, environmental specialist, New Mexico Border Health Office; Clay Chesney, geologist, U.S. EPA, Region 6.

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REFERENCES


Review

Pathogens in livestock waste, their potential for movement through soil and environmental pollution

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Accepted 10 September 1994

Abstract

Livestock wastes contain many pathogenic microorganisms including bacteria, viruses and protozoa. Following the application of these wastes to land the potential exists for environmental contamination. Plants, soil and ultimately water courses which may subsequently be used as catchments for public water supplies may all be affected. Research attention is now being focused on this possibility, especially in the case of protozoan pathogens which may be the most important as they are often resistant to current methods used in public water treatment. In this review we highlight some of the many factors that are likely to influence the degree of pollution by their effect on both the vertical and horizontal transport of microorganisms through soil. Soil pH, temperature, the presence of plants, microbial surface properties, type of waste, soil type and soil water content and flow may all affect the rate and extent of vertical transport, with the latter two generally considered to be the most important. Lateral movement is a particular problem in soils with impermeable substrata or in waterlogged conditions and in these cases the major factors affecting movement include rainfall rate, topography of the land and the rate at which microorganisms partition into the runoff.

Keywords: Livestock waste: Movement: Pathogens: Pollution: Soil

1. Introduction

Most farm livestock are housed for at least part of the year, and during this period, faeces, urine, bedding material and waste water is collected, either as semi-liquid slurry or solid manure. It is estimated that approximately 200 million t of waste are produced by livestock in England and Wales each year (National Rivers Authority, 1992). Cattle and sheep account for about 90% of this total with about half being voided directly onto pasture during grazing and half being collected in buildings. Although of potential value as fertiliser, these wastes pose a pollution threat due to their high biochemical oxygen demand and their ability to release nitrates and phosphates to the aquatic environment. The codes of Good Agricultural Practice for Protection of Water and Air (MAFF, 1992a,b) contain advice and recommendations to enable farmers to minimize the risk of chemical pollution. However, livestock wastes also contain large numbers of microorganisms, including many potential pathogens (Kearney et al., 1993a) and it is only recently that concern has been expressed about the possible spread of these pathogens to the human population (Fernan-
waste type. It has been shown that organic compounds are able to compete with viruses for adsorptive sites on soil colloids (Carlson et al., 1968), and studies have shown that waste type can influence viral transport in soil. Results obtained by Dizer et al. (1984) illustrated this by showing adsorption of virus particles from a tertiary (chemically) treated wastewater effluent to be greater than that from the corresponding secondary (biologically) treated effluent. Similarly, Lo and Sproul (1977) demonstrated that extraneous organic matter competed for adsorption sites with poliovirus. They showed that not only was viral adsorption decreased but that desorption of bound virus from silicate minerals also occurred in the presence of proteinaceous material. However, contrasting results were obtained in a study by Rees (1990) investigating the movement of faecal coliforms in soil following the application of different waste types. Whilst waste type still affected the degree of microbial movement in this case it was shown that whilst bacteria were detected in the leachate of columns treated with dirty water 1–3 h after simulated rainfall, it took twice as long for them to appear in the leachate of slurry treated columns. This may have been a result of the physical retention or binding of the bacteria within the slurry matrix.

The major source of contamination on most farms is likely to be from slurry or farmyard manure. Prior to agricultural intensification, livestock were often bedded on large amounts of straw and the waste managed as farmyard manure (Jones, 1982). However, as herd size and the number of housed animals has increased there has been a move towards the collection of waste in a semi-liquid slurry form which contains only a minimum amount of solid bedding material. It is estimated that 50–60% of waste from housed cattle is now managed as slurry (Smith and Unwin, 1983). Traditionally, farmyard manure was composted, an aerobic process where temperatures often rise as high as 70°C and therefore the majority of pathogens were destroyed (Jones, 1980). However, in intensive systems slurry is collected and stored under conditions which rapidly become anaerobic and hence temperature rise and the

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Viruses</th>
<th>Protozoa/parasites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetobacter spp.</td>
<td>Coronavirus</td>
<td>Cryptosporidium parvum</td>
</tr>
<tr>
<td>Bacillus amyloliquefaciens</td>
<td>Enterovirus</td>
<td>Rotavirus</td>
</tr>
<tr>
<td>Brucella abortus</td>
<td></td>
<td>Giardia lamblia</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td></td>
<td>Clostridia sp.</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td></td>
<td>Listeria monocytogenes</td>
</tr>
<tr>
<td>Lactobacillus spp.</td>
<td></td>
<td>Mycobacterium tuberculosis</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td></td>
<td>Salmoneella spp.</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td></td>
<td>Streptococcus spp. (including faecal streptococci)</td>
</tr>
<tr>
<td>Salmoneella spp.</td>
<td></td>
<td>Yersinia enterocolitica</td>
</tr>
</tbody>
</table>

Table 1: Examples of pathogenic microorganisms which may be found in livestock waste (compiled from information contained in Wray (1975); Williams (1979); Reddy et al. (1981); Larsen and Munch (1986); Henry (1991); Hinton and Bale (1991) and West (1991)).
lies are therefore required to investigate ways in which bacterial numbers may be reduced prior to the application of wastes to land (Havelaar, 1986). Chlorination of human drinking water will generally destroy *Salmonella* spp. However, in rural areas where drinking water is supplied by wells and streams which drain off land where extensive grazing takes place, such as the uplands of Wales, hazards could still exist.

4.2. Protozoa

4.2.1. *Cryptosporidium*

Members of the genus *Cryptosporidium* are coccidian protozoa of the family *Cryptosporidiidae*, phylum Apicomplexa (Current, 1987). Although there are seven recognized species of *Cryptosporidium* the majority of research has focused on *Cryptosporidium parvum* as this species is the cause of clinical disease in man and zoonotic infections in livestock and other mammals (Robertson and Smith, 1992). Until recently cryptosporidiosis was considered rare in animals and man, and associated only with immunocompromised patients. However, research over the last decade has resulted in its recognition as an important pathogen of both animals and man. Many studies in different countries have demonstrated that *C. parvum* is detected in a large proportion of diarrhoeal outbreaks of cattle, sheep and pigs (Reynolds et al., 1986; Angus, 1990; Robert et al., 1991; Villacorta et al., 1991). In cattle and sheep cryptosporidiosis and the associated diarrhoea is almost exclusive to young animals and thus peaks of disease outbreaks occur around lambing and calving times (Fig. 2). Infection with *Cryptosporidium* often occurs in conjunction with other enteropathogens such as rotavirus, enteropathogenic *E. coli* and *Salmonella* spp., and such multiple infections increase both morbidity and mortality rates (Angus, 1990).

Infection with *Cryptosporidium* occurs following ingestion of the transmissive oocyst (4–6µm in diameter). Oocysts are excreted in large numbers (up to $1 \times 10^{10} \text{ g}^{-1}$) in the faeces of infected animals (Smith, 1992) and, since ingestion of as few as ten oocysts can result in disease, the potential for infection is huge. The severity of disease is governed by the immunological status of the host (Ungar, 1990). In man, infection may occur at any age, although due to their lower hygiene levels, incidence in pre-school children is greater than in older children and adults (Grimason et al., 1990). In immunocompromised patients infection with *Cryptosporidium* is not limited to the gastrointestinal tract and both respiratory tract and biliary infections have been reported. In patients with AIDS, gastrointestinal infection with *Cryptosporidium* results in severe protracted diarrhoea and the loss of large quantities of watery faeces (Current, 1987). In such cases the diarrhoea may be irreversible and will ultimately result in death.

Infection in the immunocompetent patient is generally less severe. Symptoms include diarrhoea, abdominal pain, anorexia, vomiting, fever and flu-like...
Table 2
Some factors influencing the movement of microorganisms through and across soil

<table>
<thead>
<tr>
<th>Movement</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>Bitton et al. (1974), Tan et al. (1991), Huyxman and Versvante (1993a)</td>
</tr>
<tr>
<td>Soil type</td>
<td>Woon and Griffith (1976), Worrall and Roughley (1991)</td>
</tr>
<tr>
<td>Soil water content</td>
<td></td>
</tr>
<tr>
<td>Rainfall/intensity of rainfall</td>
<td>Wollum and Cassell (1978), Madsen and Alexander (1982), Trevers et al. (1990), Huyxman and Verstrante (1993b)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Kemp et al. (1992)</td>
</tr>
<tr>
<td>pH</td>
<td>Dubois et al. (1976), Burge and Enkiri (1978), Kemp et al. (1992)</td>
</tr>
<tr>
<td>Mesofaunal activity</td>
<td>Rusdiek and Williams (1972), Opperman et al. (1987)</td>
</tr>
<tr>
<td>Surface properties of microorganism</td>
<td>Bitton (1975), Stenstrom (1989), Gunon et al. (1991), Huyxman and Versvante (1993c)</td>
</tr>
<tr>
<td>Presence of plant roots</td>
<td>Howie et al. (1987), Trevers et al. (1990), Van Elas et al. (1991), Mawdsley and Burns (1994)</td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
</tr>
<tr>
<td>Rainfall/intensity of rainfall</td>
<td>Evans and Owens (1992), Pani et al. (1985), Couilllard and Li (1993)</td>
</tr>
<tr>
<td>Topography of land and proximity to pollutant source</td>
<td>Baxter-Potter and Gilliland (1988), Pani et al. (1985)</td>
</tr>
<tr>
<td>Agricultural practice</td>
<td>Young et al. (1980), Moore et al. (1989), Walker et al. (1990), Couilllard and Li (1993)</td>
</tr>
</tbody>
</table>

Currently appears to be the most effective technique for removing cysts from water. Ozone has been shown to have cysticidal properties in laboratory studies (Finch et al., 1993b) and hence may be of use although more data is required on the effect of factors such as treatment temperatures and water quality before an accurate picture of its reliability and feasibility in water treatment plants is achieved.

4.3. Viruses

4.3.1. Rotavirus

Rotaviruses are a relatively recently discovered group of the Reoviridae and are now recognised as one of the major causes of non-bacterial infantile diarrhoea (WHO, 1979). As with the other organisms, infection is via the faecal-oral route with up to 1 x 10^9 infective virions being excreted per gram of faeces (Weckerle, 1986). Infection results in symptoms ranging from sub-clinical to mild diarrhoea to severe and occasionally fatal dehydrating illness. Symptoms are generally most severe in infants up to 2 years of age, although adults may be infected. Malnourished and immunocompromised individuals are more susceptible to disease and in these cases mortality rates are much higher (Kapitkian and Chanock, 1985).

The association between rotaviruses and waterborne gastroenteritis has highlighted the need for research on both the occurrence and fate of the virus in livestock waste, and aquatic and terrestrial systems (Pancorbo et al., 1987, Ward et al., 1989). A study by Reynolds et al. (1986) of 490 calves with diarrhoea showed that rotavirus was the most frequently isolated causative agent, being responsible for > 50% of the recorded outbreaks. The number of reported incidents of rotavirus infection in the UK in recent years is shown in Fig. 1, and it can be seen that since the mid 1980s the number of reported cases has almost doubled.

5. Factors influencing microbial movement through soil

5.1. Vertical movement

Unless land is saturated or of an impermeable nature, when wastes are applied vertical movement of microorganisms through the soil will occur. Despite evidence of the existence of a wide variety of pathogens in livestock waste, few studies have examined vertical or horizontal movement of these microorganisms through soil. In the absence of such information we have drawn on material accumulated in relation to comparable non-
et al., 1976; Wessendorf and Lingens, 1989; Hozore and Alexander, 1991), whereas other species such as Arthrobacter and Azospirillum are relatively resistant (Lageda et al., 1976; Bishan et al., 1991). As soil pores become increasingly water filled, bacteria may find themselves in an anoxic or at least microaerophilic environment (Griffin, 1981) and for obligate aerobes this will probably result in decreased viability and survival.

Studies of both bacteria and viruses indicate increased movement in saturated soils. As matric potentials fall, water will drain from pores and hence water content together with pore size will determine the ability of microorganisms to move through soil whether by active movement or Brownian motion with results generally indicating increased movement in saturated soil (Wong and Griffin, 1976; Worroll and Roughley, 1991). Studies by Postma et al. (1989) suggest a possible explanation for this phenomenon. In their study, maximum incorporation of Rhizobium leguminosarum cells into soil aggregates occurred when the bacterium was inoculated into soil at low water contents. As the water content at time of inoculation increased, the numbers of cells bound in stable aggregates decreased; they hypothesized that this was due to water in pores preventing penetration by the bacteria.

In addition to soil water content, percolating water, either in the form of irrigation or rainfall will affect translocation through the soil matrix. Trewors et al. (1990) showed that in the absence of downward water flow, movement of a Pseudomonas fluorescens strain in soil columns was negligible, whereas following percolation the bacterium could be detected throughout the soil column and in the leachate. Similarly, Madsen and Alexander (1982) showed increased movement of both Rhizobium and Pseudomonas following percolation of soil cores.

Water flow rate, as governed by the intensity of rainfall, will also affect the rate and extent of translocation with faster flow rates increasing movement of both bacteria (Woolam and Cassel, 1978; Trewors et al., 1990; Huysman and Verstraete, 1993b) and viruses (Lance and Gerba, 1980; Lance et al., 1982). Field studies support these observations. Evans and Owens (1972) showed that the concentration of coliforms and enterococci in a subsurface drain of a field receiving pig wastes increased during high rates of drain discharge. Similarly, Pattni et al. (1984) found higher concentrations of total coliforms, faecal coliforms and faecal streptococci in drainage waters from manured fields following periods of heavy rainfall.

Saturated water flow is another factor which must be considered. In this situation water flow is through large pores and channels and hence the filtering effect of soil is largely bypassed (McCoy and Hagedorn, 1979) and hence the risk of both chemical and biological pollution increased. Rahe et al. (1978) illustrated this showing rapid (1500 cm h⁻¹) transport of E. coli cells through saturated hillslope soils. High recovery rates indicated that once cells had entered macropores they were relatively unaffected by passage through the soil profile.

5.1.3. Surface properties

The surface properties of microorganisms may affect their association with soil particles and hence their survival and transport in soil (Huisman and Verstraete, 1993c). Hydrophobicity, cell size and properties such as the presence of cellular appendages have all been shown to affect microbial movement (Stenstrom, 1989; Gannon et al., 1991; De Mot et al., 1991). However, such properties do not act in isolation and are influenced by external factors such as the presence of cations and the organic matter content of the soil or waste.

The mobility of viruses in soil is related to the properties of the amphoteric viral protein coat (Frankenberger, 1986). It is widely accepted that viral adsorption is increased in the presence of cations, as the repulsive forces of the virus particles and soil colloids are neutralized (Bitton, 1975) and that the formation of virus–cation–clay bridges (i.e. the increase in virus adsorption) increases with increasing positive charge (Frankenberger, 1986).

5.1.4. Soil pH

Both high and low pH values are known to decrease the survival of most bacterial and viral pathogens (Hurst et al., 1980; Reddy et al., 1981) although protozoal cysts are in general considered more resistant to extremes of pH (Williams, 1979). Both the biological and physico–chemical properties of soil are affected by pH and this in turn will affect survival and transport of microorganisms. However, pH measurements of soil reflect only its bulk pH and not those of individual microenvironments. Within the soil, spatial variations in pH will influence the survival and transport of micro
et al., 1976; Wessendorf and Lingens, 1989; Hozore and Alexander, 1991), whereas other species such as *Arthrobacter* and *Azospirillum* are relatively resistant (Lageda et al., 1976; Basban et al., 1991). As soil pores become increasingly water filled, bacteria may find themselves in an anoxic or at least microaerophilic environment (Griffin, 1981) and for obligate aerobes this will probably result in decreased viability and survival.

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USDA Animal Agricultural Research Center
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August 1997
000562
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PREFACE

This publication responds to the request made at the 1994 University of California conference, Animal Agriculture Impacts on Water Quality, for a single-source non-technical publication that reviews current knowledge about pathogens excreted by livestock which could be transmitted from livestock to humans via water. The author, Edward R. Atwill, DVM, MPVM, PhD, is environmental animal health specialist and assistant veterinarian at the UC Davis, Veterinary Medicine Teaching and Research Center located in Tulare, California.

Related publications in this series from the UC Agricultural Issues Center and UC Davis Animal Agriculture Research Center include the conference summary, Animal Agriculture Impacts on Water Quality, and three reports, Technologies and Management Practices for More Efficient Manure Handling; Livestock Management in Grazed Watersheds: A Review of Practices that Protect Water Quality; and The Economic Merit of Animal Manures as a Source of Plant Nutrients or Energy Generation.

UC Agricultural Issues Center

ACKNOWLEDGMENTS

The author wishes to thank Marcia Kreith, program analyst at the UC Agricultural Issues Center and technical editor of this publication, and Corrin Rausenberger and Sandy Fisher, also of the AIC, for publication design and preparation. In addition to the outside reviewers, Ian Garnett, acting director, UCD Animal Agriculture Research Center, and Stephanie Weber Smith, formerly of the Agricultural Issues Center, offered useful suggestions on the initial draft.
INTRODUCTION

Protecting surface water quality in the face of a burgeoning human population has become a major challenge for western states such as California. One of the many concerns regarding water quality is to minimize the concentration of pathogens in water and thereby minimize the risk of waterborne disease to humans or to animals. The focus of this article is to review the list of pathogens which can be shed in the excrement of livestock and transmitted to humans through water. The term,* waterborne zoonotic disease, is commonly used by public health researchers to refer to pathogens which are transmitted via water from animals to man.

Four primary steps need to occur for waterborne transmission of pathogens from livestock to humans. Eliminate any one of these steps and transmission of the specific pathogen from livestock to humans through water can be significantly reduced or even stopped completely. First, the pathogen must be excreted by livestock. Second, the pathogen must reach a water supply either by the animal defecating in water, by overland flow (runoff from a grazed pasture during rainfall, snowmelt, etc.), by subsurface flow, or by some combination of these three pathways. Third, the pathogen must retain the cellular functions necessary for initiating a new infection in humans during the time it is in the environment. Lastly, given that the pathogen is shed by livestock, reaches a water source, and remains infective until ingested by a human, the concentration of infective pathogens must be sufficiently high in order to initiate an infection. The minimum number of pathogens needed to initiate infection varies from pathogen to pathogen. For example, the protozoan parasites, Cryptosporidium parvum and Giardia lamblia, have a very low infectious dose (DuPont et al. 1995; Rendtorff, 1954). In contrast, for bacteria such as Campylobacter jejuni or Salmonella typhimurium, hundreds or thousands of those bacteria need to be ingested in order to initiate an infection (Robinson, 1981; Black et al. 1988).

Protozoa
Primary Concern

Waterborne zoonotic protozoa of primary concern and with a feasible livestock component should include at a minimum Cryptosporidium parvum and Giardia duodenalis. The principle features of these protozoa are: the infective stages of Cryptosporidium parvum (the oocyst) and Giardia duodenalis (the cyst) do not reproduce outside the host, the apparent low infectious dose necessary to initiate an infection in humans, and the relative resistance of waterborne cysts and particularly oocysts to chemical disinfectants (Sterling, 1990).

*See Glossary on page 10
Cryptosporidium parvum

Cryptosporidium parvum (C. parvum) is a tiny protozoal parasite that is shed by humans, cattle, sheep, goats, pigs, and horses (Fayer and Ungar, 1986). It is also shed by various wildlife species such as deer, raccoons, opossums, and rabbits. C. parvum is not known to replicate within and be shed by chickens or turkeys. The infectious stage of this pathogen is an environmentally-resistant egg, or oocyst, which is infective once shed by the host. These oocysts can be shed for several days by an infected animal, with up to 10 million oocysts per gram (approximately 280 million per ounce) of feces during the peak of shedding (Blewett, 1989; Goodgame et al. 1993; Xiao and Herd, 1994a). Shedding is usually limited to livestock under 6 months of age (Xiao and Herd, 1994a; Kirkpatrick, 1985; Sanford, 1987; Xiao and Herd, 1994b), but shedding around lambing has been documented in ewes (Xiao et al. 1994). Therefore, watershed management strategies designed to minimize potential livestock contamination of surface water with C. parvum should focus on the young and possibly on animals close to lambing or calving. There are many livestock production systems in which the young are typically excluded from a group of animals, such as feedlots, some slaughterhouses, dairies who do not raise their own calves, and backgrounder/stocker beef cattle operations (calves 6-14 months old) where the risk of shedding is likely to be minimal. Researchers in Europe have reported shedding of C. parvum in adult beef cattle (Scott et al. 1995; Lorenzo et al. 1993), but this has not been confirmed by studies in this country (Xiao and Herd, 1994a; Kirkpatrick, 1985; Sanford, 1987; Xiao and Herd, 1994b).

Although the occurrence of waterborne outbreaks of human cryptosporidiosis is well documented, the source of the organism is typically unknown (Juranek, 1995; Atwill, 1996; Sterling, 1990; Smith and Rose, 1990). This is somewhat troubling since Cryptosporidium oocysts were present in 39-87% of the surface waters (rivers, lakes, etc.) that were tested throughout the United States during 1988-1993 (Rose et al. 1991; LeChevallier et al. 1991; LeChevallier and Norton, 1995).

If the livestock feces are deposited on dry land, the means by which C. parvum oocysts travel from the manure to a nearby body of water are not well understood. Factors such as soil type, slope, vegetation, and other factors present on California lands used for livestock production will affect the process. Research using intact soil columns and simulated rainfall indicates that C. parvum oocysts are carried up to 30 cm (approximately 12 inches) through clay loam, silty loam, and loamy sandy soil, but the majority of oocysts remained within the upper 2 cm (approximately 3/4 inches) of the soil column (Mawdley et al. 1996). Oocysts appear to die after several hours of being dry, but such results need to be interpreted with caution since infectivity was determined by indirect assay (Robertson et al. 1992).

Temperature has also been shown to influence the viability of the oocyst. Oocysts recovered from calf feces which had been kept inside a barn in summer or inside an unheated shed in winter became non-infective for mice in 1-4 days (Anderson, 1986). C. parvum oocysts become non-infectious if frozen for longer than 1 hour at minus 70° C, longer than 24 hours at minus 20° C, and longer than 168 hours at minus 15° C (Fayer and Nered, 1996). What if fecal material is deposited directly
in a stream? One study found that after 33 days in cold river water, an estimated 34-
40% of purified oocysts were apparently non-viable, using an indirect assay. After
176 days, 89-99% mortality was reported (Robertson et al. 1992). Although there
are severe environmental pressures against oocysts remaining infective when excreted on land, only a few oocysts would need to remain viable in order to pose a
risk to humans. Experimental studies in healthy humans determined that the infectious dose at which 50% of subjects acquired infection (ID50) was 132 bovine-derived oocysts (DuPont et al. 1995). As few as 30 oocysts were shown to induce
cryptosporidiosis (DuPont et al. 1995), but since a dose of less than 30 oocysts was
not fed to the volunteers, the minimal infectious dose could be lower.

*Giardia duodenalis* (G. *intestinalis*, G. *lamblia*)

Waterborne giardiasis in humans is well documented, with over 100 reported
outbreaks since 1965. Contamination of surface water with human sewage was
responsible for a majority of these outbreaks, but the source of infection for sporadic cases of waterborne human giardiasis is much less clear (Craun, 1990; Levine
et al. 1991; Thompson and Boreham, 1994). Similar to the widespread presence of
*Cryptosporidium* oocysts in surface water (LeChevallier et al. 1991), a majority of
surface water samples also contained *Giardia* cysts. This creates some concern
given the ability of *Giardia* cysts to survive extended periods of time under moist
and cool environmental conditions (de Regnier et al. 1989) and the low infectious
dose for humans (Rendtorff, 1954). Similar to *C. parvum*, *G. duodenalis* is
commonly shed by a wide variety of livestock species, wildlife, companion animals and
humans (Xiao and Herd, 1994a; Xiao and Herd, 1994b; Xiao et al. 1994; Erlandsen,
1994; Wallis, 1994). It has not been determined which of these sources, including
humans and their sewage treatment facilities, are the primary source(s) of *G.
duodenalis* for surface water in California.

Unlike *C. parvum* in which there is clear evidence for its infectious potential
in humans (DuPont et al. 1995), considerable controversy surrounds the issue of
whether *G. duodenalis* cysts obtained from livestock can infect humans. Two re-
views (Thompson and Boreham, 1994; Erlandsen, 1994) of the scientific literature
both concluded that convincing data for the zoonotic potential of *Giardia* still does
not exist. Additional review articles debating this issue can be found in an article by
Erlandsen (1994). Fayer (1994) also concluded that “no human infection related to
these animals has been reported” with respect to pigs, cattle, sheep, and goats. Al-
though unequivocal evidence is lacking regarding successful transmission of *G.
duodenalis* cysts from livestock to humans via water, finding such evidence remains
very difficult given the investigator’s poor ability to identify the vertebrate source
of waterborne *G. duodenalis* cysts (Thompson and Boreham, 1994). The serious-
ness of this debate should not be overlooked as the implementation of the US EPA’s
Information Collection Rule and development of the Enhanced Surface Water Treat-
ment Rule approaches. This debate also remains central to the growing national
interest in developing watershed management plans that minimize the risk of water-
borne giardiasis and other waterborne diseases in humans.
Secondary Concern

This group includes waterborne protozoa of secondary importance whose waterborne transmission to humans do not appear to have a major livestock component, or where a waterborne route is rarely documented. All cats (Felis) can serve as the definitive host for Toxoplasma gondii, hence, livestock are incapable of contaminating water with the infective oocyst (Acha and Szyfres, 1987; Fayer, 1994). Balanidium coli, a ciliated protozoan found in the intestines of humans and pigs, is a rarely reported disease. Its potential to be transmitted from pigs to humans remains controversial (Acha and Szyfres, 1987). The reservoir of the intestinal amoeba, Entamoeba histolytica, is thought to be humans, with livestock having no clear role in human infection (Acha and Szyfres, 1987; Fayer, 1994). Cyclospora cayetanensis and the opportunistic intestinal microsporidia, Enterocytozoon bieneusi and Septata intestinalis, are not known to have a livestock reservoir at this time (Goodgame, 1996).

Bacteria
Primary Concern
Campylobacter spp

There are several species of Campylobacter which can cause infection in humans (e.g., C. jejuni, C. coli, C. lardi, C. fetus subspecies fetus), with C. jejuni accounting for almost all of the diagnosed cases. There are approximately two million cases of human campylobacteriosis per year in the United States, comparable to the estimated annual incidence of human salmonellosis. The majority of human campylobacteriosis occurs as sporadic cases as opposed to outbreaks involving large numbers of people (Tauxe, 1992). C. jejuni is common in the environment and shed in the feces of humans, livestock, and wildlife, including birds. It is also found in a wide variety of surface waters, stream sediments, and sewage effluents (Tauxe, 1992; Stern, 1992). The primary routes of transmission appear to be ingestion of contaminated foods (primarily poultry and raw milk), ingestion of untreated surface water, and contact with pets (primarily dogs) suffering from diarrhea. Direct human-to-human transmission occurs only rarely (Tauxe, 1992; Altekruse et al. 1994; Franco and Williams, 1994; Adak et al. 1995). Rough estimates attribute 19% of outbreak-associated and 9% of sporadic human campylobacteriosis to waterborne transmission (Tauxe, 1992). A common vehicle of foodborne transmission is raw milk (primarily cattle) and inadequately cooked poultry presumably contaminated with infective feces. Thus it is feasible that manure from cattle and poultry operations or from the effluent of slaughterhouses or poultry processing plants could contaminate water supplies with strains of C. jejuni which are infectious to humans (Stern, 1992). Feces from cattle and poultry and effluent from poultry processing facilities have been shown to contain C. jejuni which in some cases are very similar to human isolates (Tauxe, 1992; Stern, 1992; Altekruse et al. 1994; Koenraad et al. 1995). Similarities between pathogens obtained from humans and poultry do not establish causal connection or its direction; they only provide tentative support that cross-transmission is occurring. C. jejuni can survive for a limited time in stream water.
(Terzieva and McFeters, 1991), and as few as 500–800 organisms appear sufficient to cause clinical illness in humans (Robinson, 1981; Black et al. 1988). Despite these findings, documented cases of human campylobacteriosis attributable to water contaminated with livestock manure or livestock effluent are uncommon. This is not the result of other vertebrate sources being identified as the contaminating source instead of livestock since the source remains unidentified (Cowden, 1992). Better DNA fingerprinting techniques and more sensitive and specific methods for identifying C. jejuni in water and other environmental sources should help identify the primary source(s) of this common cause of gastroenteritis in humans.

*Salmonella* spp

Human infection with non-typhoid causing *Salmonella* species remains one of the primary foodborne pathogens for humans. However, a concise review of the role of livestock in the annual incidence of waterborne human salmonellosis is difficult at best. The large number of serotypes and their highly variable medical ecology across both geography and time, and between vertebrate hosts, have made analysis difficult. The most noticeable observation regarding human salmonellosis is the lack of reported waterborne outbreaks definitively traced to livestock (Acha and Szyfres, 1987; Ziprin, 1994).

Although non-typhoidal *Salmonella* species are widely present in domestic and wild animals, livestock are important sources for several serotypes infectious to humans. For example, *S. dublin* is one of the more frequently isolated serotypes from cattle (Ferri and Miller, 1990) and a serious foodborne pathogen for humans. Cattle have been shown to persistently shed *S. dublin* in their feces following infection with this serotype (Sokka et al. 1974). *S. newport* has been shown to survive extended periods of time in freshwater sediments (Burton et al. 1987). It is plausible that surface water contaminated with bovine-derived *S. dublin* or foods rinsed in contaminated water could serve as vehicles of human infection. *S. typhimurium* is another common isolate from cattle (Graeber et al. 1995). In Germany, isolates of *S. typhimurium* which were obtained from nearby calf-rearing facilities were not the strains contaminating associated coastal waters nor the isolates obtained from nearby human patients (Graeber et al. 1995), but studies such as this provide no assurance regarding the modes of transmission in the United States. *S. enteritidis*, now one of the most commonly isolated serotypes from human cases, is highly associated with ingestion of contaminated shell eggs (Mishu et al. 1994). Whether manure from layer or other poultry operations or the effluent from poultry processing facilities is a significant source of waterborne salmonellosis in humans is unclear at this time.

**Various pathogenic strains of E. coli**

(Enteropathogenic/Enterotoxigenic/Enteroinvasive/Enterohemorrhagic)

Some strains of pathogenic *E. coli* have emerged as leading foodborne pathogens for humans, but their role in waterborne diseases is less clear (Neill et al. 1994). It is important to realize that the *E. coli* referred to during general water quality tests (total coliforms, fecal coliforms, *E. coli*, etc.) are not necessarily pathogenic strains, but instead are an indicator of general fecal contamination. When used as an indica-
tor of water quality, *E. coli* refers to the harmless strain of this facultative anaerobe which helps maintain normal intestinal functions (Drasar and Hill, 1974).

Although subclassification of this group of pathogens is still under development, there are four primary categories of pathogenic *E. coli* (enteropathogenic, enterotoxigenic, enteroinvasive, enterohemorrhagic), each with their own common and unique features. The reader is referred to Neill (1994) for a more thorough review. Several waterborne outbreaks of pathogenic *E. coli* have been reported, but livestock were not definitively identified as the source of contamination (Lanyai et al. 1959; Schroeder et al. 1968; Swerdlow et al. 1992). With respect to sporadic human cases of pathogenic *E. coli*, whereby livestock are the source of contamination, it is unknown what component is attributable to waterborne transmission. While enteroinvasive *E. coli* have not been isolated from animals, the highly pathogenic (for humans) enterohemorrhagic *E. coli* (O157:H7) have been cultured from a low proportion of cattle (Wells et al. 1991).

*Yersinia* spp

The estimated number of cases of human infection with *Yersinia* species in the United States is 3,000-20,000 per year, far less than the reported number of cases of campylobacteriosis and salmonellosis (Roberts, 1989; Todd, 1989). Most of these infections are due to *Yersinia enterocolitica* in the United States; one of the primary routes of transmission being foodborne and waterborne (Feng and Weagant, 1994). The proportion of sporadic cases attributable to food versus water versus other routes of transmission is not well established. The bacteria are widespread in water (streams and lakes), foods (pork products, vegetables, dairy products, tofu, seafood), wild and domestic animals, and humans, but many of the strains obtained from these sources were not pathogenic for man. Relative to *Campylobacter jejuni*, *Yersinia enterocolitica* is better able to survive in stream water (Terzieva and McFeters, 1991). Despite swine being considered as one of the primary environmental reservoirs of these bacteria, documented waterborne outbreaks of human yersiniosis have not been definitively linked to livestock (Acha and Szyfres, 1987). It could be argued that due to the low number of cases of human yersiniosis this pathogen would be classified as a waterborne disease of secondary importance in the United States.

Secondary Concern

This group includes waterborne protozoa of secondary importance whose waterborne transmission to humans do not appear to have a major livestock component, or where a waterborne route is rarely documented. *Clostridium perfringens* types A and C are found in human and animal feces, soil, green and decaying plant material, sewage, and water (Wrigley, 1994). It is a common cause of foodborne illness in humans, but is not recognized as a primary waterborne disease nor is there a clear role for livestock in the medical ecology of waterborne infection (Acha and Szyfres, 1987). *Listeria monocytogenes*, a very common bacterium, has been associated with large foodborne outbreaks of disease (Fleming et al. 1985; Linnan et al. 1988; Donnelly, 1994), but is not recognized as a primary waterborne disease nor is there a clear role for livestock (Acha and Szyfres, 1987; Skovgaard and Morgen, 1991).
1988; Schuchat et al. 1991). Moreover, if the waterborne route comprises a minor part of the annual incidence of sporadic human listeriosis, then the incidence for waterborne listeriosis will be considerably less than the overall total annual incidence of seven cases per million people (Schuchat et al. 1992). It could be argued that if the case fatality rate associated with waterborne infection was similar to that seen with foodborne infection (23%), even small levels of waterborne transmission may pose a serious health risk (Schuchat et al. 1992). The waterborne route of transmission is not known to play a significant role in human infection with *Brucella* spp. (Acha and Szyfres, 1987; Chomel et al. 1994). Human infections with serovars of *Leptospirosis interrogans* are rare and confined mostly to direct contact with infected animals, as might occur among veterinarians and slaughterhouse workers (Acha and Szyfres, 1987; Heath and Johnson, 1994). Although occasional waterborne outbreaks have been reported, the role of livestock is unclear (Shaw, 1992; Jackson et al. 1993).

**Viruses**

At this time there is little evidence that the group of viruses shed in the excrement of livestock have posed a waterborne threat to human health in the United States (Cliver, 1994). Although interspecies transmission of rotaviruses has been demonstrated experimentally, the role of livestock-derived rotaviruses in the epidemiology of human waterborne infection is not known (Acha and Szyfres, 1987).

**CONCLUSION**

Although a variety of protozoa and bacteria can be shed by livestock and transmitted to humans through water, the relative significance of this route of transmission in the overall epidemiology of human infection is not clear. The reason for this lack of clarity is that humans and various wildlife species can also shed these pathogens and thereby serve as a source of infection for humans. For example, both protozoal parasites, *Cryptosporidium* and *Giardia*, and various *Salmonella* and *Campylobacter* species can be shed by humans and various wildlife. Animal agri-
culture is likely responsible for a percentage of many of the pathogens we find in surface water, but whether that percentage is 5%, 50% or 95% compared to non-agricultural sources such as humans or wildlife is unknown at this time for most watersheds (see figure below). For example, it is unknown what proportion of the annual incidence of human cryptosporidiosis (infection with the protozoal parasite, Cryptosporidium parvum) is attributable to waterborne transmission compared to foodborne, direct human-to-human, or direct animal-to-human transmission. If we spend our public health dollars on controlling waterborne cryptosporidiosis yet the primary route of transmission for humans is direct human-to-human fecal-oral transmission, then we will likely have little impact on reducing the annual incidence of this disease despite having controlled the waterborne route of transmission. Moreover, the annual incidence of waterborne cryptosporidiosis cannot be separated into the proportion attributable to domestic animals, wildlife, and humans (Juranek, 1995; Atwill, 1996). Again, if the primary source of waterborne C. parvum is human sewage, then regulatory policies that focus on animal agriculture will likely have little impact on reducing the concentration of waterborne C. parvum. Of course, if animal agriculture is the primary source of these pathogens, then minimizing fecal contamination of water with livestock manure will have a dramatic impact on reducing human infection. The advent of new DNA fingerprinting tools and more sensitive and specific procedures for detecting pathogens in water should help identify and better quantify sources of these pathogens in the future. In the meantime, we should proceed carefully and without assumption on how to control these waterborne pathogens and always insist that public policy is grounded in good science.
List of pathogens of primary concern that can be shed in the feces of livestock and transmitted to humans through water. Pathogens of secondary concern whereby livestock have either no role or an unclear role in human waterborne infection have also been listed.

<table>
<thead>
<tr>
<th>Waterborne protozoa pathogens of primary concern (known livestock component)</th>
<th>Special concerns and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptosporidium parvum</td>
<td>Low infectious dose; environmentally resistant oocysts; oocyst 5 x 5 microns</td>
</tr>
<tr>
<td>Giardia duodenalis</td>
<td>Low infectious dose; environmentally resistant cysts; zoonotic potential under debate; cysts approximately 12 x 15 microns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waterborne protozoa pathogens of secondary concern (livestock either play no role or role is unclear)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxoplasma gondii</td>
<td>Felines are the definitive host, not livestock</td>
</tr>
<tr>
<td>Balantidium coli</td>
<td>Swine suspected, but no clear role</td>
</tr>
<tr>
<td>Entamoeba histolytica</td>
<td>Human reservoir</td>
</tr>
<tr>
<td>Cyclospora cayetanensis and microsporidia (Enterocyctozoon bieneusi, Septata intestinalis)</td>
<td>Unknown reservoir and livestock not known to shed these protozoa at this time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waterborne bacterial pathogens of primary concern</th>
<th>0.2 x 1.5 up to 1.5 x 6.0 microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter spp.</td>
<td>Common in livestock and wild birds</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>Common in livestock feces; a common foodborne pathogen for humans</td>
</tr>
<tr>
<td>Pathogenic strains of E. coli</td>
<td>Can be highly virulent for humans</td>
</tr>
<tr>
<td>Yersinia spp.</td>
<td>Swine are considered a primary reservoir; apparent low annual incidence in humans</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waterborne bacterial pathogens of secondary concern</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium perfringens types A and C</td>
<td>Waterborne transmission unclear</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>Waterborne transmission unclear; human infection typically foodborne</td>
</tr>
<tr>
<td>Brucella spp.</td>
<td>Waterborne transmission unclear</td>
</tr>
<tr>
<td>Leptospirosis interrogans</td>
<td>Waterborne transmission unclear; human infection typically by direct contact</td>
</tr>
</tbody>
</table>

| Waterborne viral pathogens from livestock | Little scientific evidence that viruses shed in the feces of livestock pose a waterborne health threat to humans in the U.S.A. |
GLOSSARY

Amoeba: a tiny single-celled organism which usually lives harmlessly in the environment but in some cases can parasitize humans or animals.

Campylobacteriosis: an intestinal infection caused by the bacterium, Campylobacter jejuni; the infection is commonly located within the gastrointestinal tract but it can be located elsewhere in the body.

Cilia: short hair-like projections used for propulsion that extend from the surface of some microorganisms such as protozoa.

Ciliated: presence of cilia.

Cryptosporidiosis: an infection caused by the protozoan parasite, Cryptosporidium parvum.

Cyst: a form of a protozoan parasite; the name used to signify the infective, egg-like structure of Giardia duodenalis.

DNA (deoxyribonucleic acid): the molecule (hereditary material) that encodes genetic information in an organism.

DNA Fingerprinting: the technique that identifies the unique pattern of DNA fragments in an organism.

Endemic: describes a disease that is constantly present within a population, usually at low incidence.

Enterohemorrhagic: describes a group of E. coli bacteria that causes hemorrhaging, or loss of blood from intestinal tissue.

Enteroinvasive: describes a group of E. coli bacteria that "invade" the epithelial cells of the intestine.

Enteropathogenic: describes a group of E. coli bacteria that adheres to the intestinal mucosa to produce the characteristic lesions to the microvilli.
Enterotoxigenic: describes a group of *E. coli* bacteria that produce an enterotoxin. An enterotoxin is a toxin that disrupts the fluid balance of the intestinal cells.

**Facultative anaerobe:** a microorganism that normally lives in the presence of oxygen but can grow in an environment lacking oxygen.

**Gastroenteritis:** inflammation of part or all of the gastrointestinal track (stomach, small and large intestines).

**Giardiasis:** a gastrointestinal infection caused by a microscopic parasite called *Giardia duodenalis* (also called *Giardia intestinalis* or *Giardia lamblia*).

**Listeriosis:** an infection caused by the bacterium, *Listeria monocytogenes*; the infection is commonly located within the gastrointestinal track, but it can be located elsewhere in the body.

**Microsporidia:** a group of five species of tiny protozoal parasites that can cause gastrointestinal disease in humans, especially in patients with AIDS.

**Oocyst:** a form of a protozoa parasite; the name used to signify the infective, egglike structure of species of *Cryptosporidium parvum*, *Isospora belli*, or *Cyclospora cayetanensis*.

**Opportunistic:** describes a microorganism that usually does not infect a host but under certain circumstances infects and causes disease.

**Outbreak:** the occurrence of a large number of cases of a disease in a short period of time.

**Pathogen:** a microorganism that is capable of causing disease.

**Protozoans (Protozoa):** a collection of single-celled organisms, some of which are parasitic and can cause disease and some of which live in the environment and do not infect other animals.

**Salmonellosis:** an infection caused by a variety of bacteria called *Salmonella*; the infection is commonly located within the gastrointestinal track, but it can be located elsewhere in the body.
Serotype or Serovar: a term used to identify sub-species of a pathogen, such as the many serotypes of Salmonella enteritidis or serovars of Leptospira interrogans.

Virulence: a measure of the ability of a pathogen to cause disease, whereby the more virulent the pathogen is, the more serious the disease it can cause.

Yersiniosis: an infection caused by the group of bacteria, Yersinia; the infection is commonly located within the gastrointestinal track, but it can be located elsewhere in the body.

Zoonoses: pathogens which can be transmitted from animals to humans, such as Salmonella or Cryptosporidium parvum.
REFERENCES


A MASSIVE OUTBREAK IN MILWAUKEE OF CRYPTOSPORIDIUM INFECTION TRANSMITTED THROUGH THE PUBLIC WATER SUPPLY

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James J. Kaziemczak, D.V.M., David G. Addiss, M.D., M.P.H., Kim R. Fox, P.E.,
Joan B. Rose, Ph.D., and Jeffrey P. Davis, M.D.

Abstract. Background: Early in the spring of 1993 there was a widespread outbreak of acute watery diarrhea among the residents of Milwaukee.

Methods. We investigated the two Milwaukee water-treatment plants, gathered data from clinical laboratories on the results of tests for enteric pathogens, and examined ice made during the time of the outbreak for cryptosporidium oocysts. We surveyed residents with confirmed cryptosporidium infection and a sample of those with acute watery diarrhea consistent with cryptosporidium infection. To estimate the magnitude of the outbreak, we also conducted a survey using randomly selected telephone numbers in Milwaukee and four surrounding counties.

Results. There were marked increases in the turbidity of treated water at the two Milwaukee water-treatment plants from March 23 until April 9, when the plant was shut down. Cryptosporidium oocysts were identified in water from ice made in southern Milwaukee during these weeks. The rates of isolation of other enteric pathogens remained stable, but there was more than a 100-fold increase in the rate of isolation of cryptosporidium. The median duration of illness was 5 days (range, 1 to 155). The median maximal number of stools per day was 15 (range, 1 to 90). Among 285 people surveyed who had laboratory-confirmed cryptosporidiosis, the clinical manifestations included watery diarrhea (93 percent), abdominal cramps (84 percent), fever (57 percent), and vomiting (48 percent). We estimate that 430,000 people had watery diarrhea attributable to this outbreak.

Conclusions. This massive outbreak of watery diarrhea was caused by cryptosporidium oocysts that passed through the filtration system of one of the city's water-treatment plants. Water-quality standards and the testing of patients for cryptosporidium were not adequate to detect this outbreak.

(Human infection with cryptosporidium was first documented in 1976. Since that time, cryptosporidium has been recognized as a cause of gastrointestinal illness in both immunocompetent and immunodeficient people. Infection occurs in a variety of settings; waterborne outbreaks of cryptosporidium infection have been documented in association with drinking water from a contaminated artificial well, untreated surface water, and filtered public water supplies. We report our investigation of the largest documented outbreak of waterborne disease in the United States. On April 5, 1993, the Wisconsin Division of Health was contacted by the Milwaukee Department of Health after reports of numerous cases of gastrointestinal illness that had resulted in widespread absenteeism among hospital employees, students, and schoolteachers. Little information was available about the nature of the illness or the results of laboratory tests of stool specimens from those who were ill. On April 7, two laboratories identified cryptosporidium oocysts in stool samples from seven adult residents of the Milwaukee area; none of the laboratories surveyed had found evidence of increased or unusual patterns of isolation of any other enteric pathogen.

The Milwaukee Water Works (MWW), which obtains water from Lake Michigan, supplies treated water to residences and businesses in the City of Milwaukee and nine surrounding municipalities in Milwaukee County. Either of two water-treatment plants, one located in the northern part of the city and the other in the southern part, can supply water to the entire district; however, when both plants are in operation, the southern plant predominantly serves the southern portion of the district. Examination of the two plants' records on the quality of untreated water (in situ) and treated water (that supplied to customers) revealed an increase in the turbidity of treated water from the southern plant, beginning approximately on March 21, with increases to unprecedented levels of turbidity from March 23 through April 5. These findings pointed to the water supply as the likely source of infection and led to the institution, on the evening of April 7, of an advisory to MWW customers to boil their water. The southern plant was temporarily closed on April 9.

METHODS
Investigation of Water-Treatment Plants

The policies, procedures, and physical plant of the southern MWW facility were reviewed and suspected in April 1993. Data on the monthly maximal turbidity of untreated and treated water from both plants were reviewed and analyzed from January 1983 through April 1993. Data on the daily maximal turbidity un-
examine patients in infectious and treated water, as well as the pH and temperature of treated water, were analyzed for the period from February through April 1993.

Examination of Ice Made during the Outbreak

Water that had been frozen and stored by a southern Milwaukee company in 213-liter blocks on March 25 and April 9, 1993, was collected and examined. Ice produced on each of these dates, three aliquots of water totaling 639 liters (three blocks) were filtered with peristaltic pumps and two types of filters: spin-polypropylene cartridge filters with a nominal porosity of 1 mm (approximately 1 g per minute), and 0.45-μm Millipore filters with a porosity of 0.45 μm (approximately flow rate 2 liters per minute). The filters were eluted, the eluates centrifuged, and the pellets resuspended with the use of a standard procedure; the suspensions were examined for Cryptosporidium oocysts with an immunofluorescent technique.11

Laboratory Surveillance

On April 5, surveillance for enteric pathogens began among 14 clinical laboratories in Milwaukee County. The laboratories reported the retrospective (March 1 through April 4, 1993) and prospective (April 5 through 16, 1993) test results for all stool specimens submitted for bacterial or viral culture and examination for ova and parasites. All 14 laboratories tested for enteric pathogens, and 13, all except one laboratory tested for Cryptosporidium. Cryptosporidium oocysts were performed according to standard concentration techniques with modified acid-fast staining12 (13 laboratories) or direct fluorescent antibody staining (1 laboratory).

Examination for Enteric Infection

On April 13, stool specimens were solicited from 11 Milwaukee residents with gastrointestinal illness who had been within the previous 48 hours. Stool specimens from 9 residents were tested for enteric pathogens with the use of rapid procedures for enteric bacterial and viral culture, examination for ova and parasites; and modified acid-fast staining after formalin-rather sediments. The stool specimens were examined by electron microscopy. Serum samples of all residents during the acute and convalescent phases of illness by the 11 residents were tested for antibody to the Norwalk virus.12

Laboratory-Confirmed Cryptosporidium Infection

A total of 239 people were found to have cryptosporidiosis in stool samples tested by the 11 participating laboratories between March 1 and May 20; telephone numbers were available for 267 (77 percent) of these 239 people with laboratory-confirmed cryptosporidiosis infection, and 242 (55 percent) were interviewed by telephone. Of 231 people, 261 people reported an acute illness between March 1 and May 15, 1993, and were considered case patients; the other 27 people were excluded from the study because their illnesses had begun before March 1. Telephone interviews were completed during two periods: from April 9 through April 13 (phase 1), 101 case patients were interviewed; and from April 17 through June 2 (phase 2), 246 were interviewed, including 16 of those who had been interviewed during phase 1. The same questionnaire was used in both phases to collect information on demographic characteristics and clinical illness. During the second phase, however, additional questions were asked about presenting clinical signs, weight loss, recurrent diarrhea, and length of hospital stay. People were considered to be immunocompromised if they reported having had a positive test for the human immunodeficiency virus or if they were being treated with immunosuppressive drugs, cancer chemotherapy, radiation therapy, or renal dialysis.

Clinical Cryptosporidium Infection in the MWVW Service Area

To determine representative clinical characteristics of illness among the people affected by the outbreak, a telephone survey was conducted on April 5, 10, and 12 with the use of a randomly selected telephone numbers from the MWVW service area. The first adult (20 years of age) to answer the telephone was interviewed with the same questionnaire used in phase 1 to collect demographic and clinical information from the people with laboratory-confirmed cryptosporidiosis. Survey respondents were identified as having clinical cryptosporidium infection if they reported the occurrence of watery diarrhea between March 1, 1993, and the time of the interview.

Survey of Households in the Greater Milwaukee Area

To determine the extent of the outbreak, we conducted a telephone survey of households in the greater Milwaukee area (Milwaukee County and the four surrounding counties) with the use of a randomly digit dialing method. Interviews were by telephone with members of the household; 2,466 people are residents of the area: the interviews were conducted by a company that had been commissioned to conduct the survey in one of four regions. The northern region was defined as the area that received water predominantly from the southern Water Treatment Plant, the central region received water predominately from the eastern region, and the middle section as the west area that receiving water from either plant, depending on supply and demand. In our analysis, all three of these regions were considered part of the MWVW service area. All surveyed areas not receiving MWVW water were considered to be the non-MWVW region.

Results

Investigation of Water-Treatment Plants

At the time of the outbreak, both MWVW plants treated water by adding chlorine and polyaluminum chloride (a coagulant to enhance the formation of larger particulates) at 1:1:1 ratios to the ratio of 1:1:1 ratio to the original water. Both MWVW plants treated water by adding chlorine and polyaluminum chloride to the water. After filtration, the effluent (treated water) was stored in a large clear well until it was supplied to customers. Filters were cleaned by backwashing them with water, which was then recirculated through the treatment process.

From January 1993 through January 1993, the turbidity of treated water at the southern plant did not exceed 0.4 nephelometric turbidity unit (NTU). During the period from February through April 1993, the turbidity of treated water at the southern plant did not exceed 0.25 NTU until March 18, when it increased to 0.25 NTU. From March 23 in April 1, the daily turbidity of treated water was consistently 0.45...
NTU or higher, with peaks of 1.7 NTU on March 28 and 5.2 NTU on April 1, despite an adjustment of the dose of polyaluminum chloride (Fig. 1). Although marked improvement in the turbidity of treated water had been achieved by April 1 with the use of polyaluminum chloride, on April 2 the southern plant began to use alum instead of polyaluminum chloride as a coagulant. On April 5, the turbidity of treated water increased to 1.5 NTU. During the period from February through April 1993, the turbidity of treated water at the northern plant did not exceed 0.45 NTU. There was no correlation between the turbidity of treated water and the turbidity or temperature of untreated water.

Throughout the period from February to April, 1993, samples of treated water from both plants were negative for coliforms and were within the limits set by the Wisconsin Department of Natural Resources for drinking water quality. Inspection of the southern plant revealed that a stream of Danionia, which can aid plant operators in adjusting the dose of coagulant, had been incorrectly installed and was no longer in use.

In addition, monitors designed for continuous measurement of the turbidity of filtered water were not in operation. Turbidity was monitored once every eight hours.

Examination of Ice Made during the Outbreak

Water obtained by melting ice blocks produced on March 25 and April 9, 1993, contained cryptosporidium in concentrations of 13.2 and 6.7 oocysts per 100 liters, respectively, when filtered through a membrane filter with an absolute porosity of 0.45 μm and 2.0 and 0.2 μm, respectively, when filtered from a polycarbonate filter. Each sample contained a minimum of 1 oocyst.

Laboratory Surveillance

During the period from March 1 through April 16, 1993, a total of 2,200 stool specimens were submitted to the 14 clinical laboratories in the Milwaukee vicinity for routine culture for bacterial enteric pathogens. Twenty-three specimens (0.9 percent) were positive for salmonella, 26 (0.4 percent) for shigella, and 11 (0.5 percent) for enteropathogenic E. coli. One specimen (0.1 percent) cultured for yeasts and 1 of 72 (1.4 percent) cultures for aeromonas were positive. In the same period, 14 of 1,744 stool specimens examined for ova and parasites (0.8 percent) were found to have giardia, and 5 of 266 specimens cultured for enteric viruses (2 percent) were positive. An enzyme immunoassay kit for norovirus was used to test 96 specimens, 3 of which (3 percent) were positive. From March 1 through April 6, 12 of 42 stool specimens (29 percent) tested for cryptosporidium were positive; from April 8 through April 16, 321 of 1,099 specimens (33 percent) were positive. We found no evidence of cyclospora infection. Oocysts examined by the Centers for Disease Control and Prevention were 4 to 6 μm in diameter and were positive for cryptosporidium with monoclonal antibody staining.

Examination for Enteric Infection

Cryptosporidium was identified in stool specimens from 9 of the 11 people with gastrointestinal illness (73 percent) whose stools were examined within 48 hours after the onset of illness. Stool cultures for enteric bacterial and viral pathogens, electron microscopy, and stool examination for enteric ova and parasites, including cyclospora and microsporida, were negative. None of the paired sera samples (obtained during the acute and convalescent phases of illness) had a fourfold rise in antibody to the Norwalk virus.

Laboratory-Confirmed Cryptosporidium Infection

Of the 285 patients with laboratory-confirmed cryptosporidium infection, 170 (59 percent) were female. 130 (46 percent) were hospitalized during the course of their illness, and 48 (17 percent) were immunocompromised. Their mean age was 41 years (range, 2 months to 95 years). All 285 patients had diarrhea, and 255 (90 percent) characterized it as watery (Table 1). The median duration of diarrhea was 9 days (range, 1 to 55), with a median reported maximum of 12 stools per day (range, 1 to 60). Among patients with fever, the median reported maximum temperature was 38.5°C (101°F) (range, 37.2 to 40.5°C [99 to 105°F]). The date of the onset of illness was available for 254 confirmed cases; with an onset during the period from March 1 through April 15 (Fig. 2, upper panel).

Of the 280 patients with laboratory-confirmed infection who were interviewed with the longer questionnaire, 150 (53 percent) reported weight loss, with a median loss of 4.5 kg (10 lb) (range, 0.45 to 18 kg [1 to 40 lb]), and 81 (41 percent) were hospitalized with cryptosporidium infection for a median of 5 days (range, 1 to 55). Seventy-seven patients (39 percent)
reported a recurrence of diarrhea after at least 2 days of normal stools, with a median interval of 2 days of normal stools (range, 2 to 14) before the diarrhea recurred. Recurrence of diarrhea after at least five days of normal stools was reported by 11 (6 percent) of the patients.

In general, the frequencies of signs and symptoms of illness were similar in immunocompromised and immunocompetent patients. However, the immunocompromised patients had more diarrheal stools per day (mean, 15 vs. 12; *P = 0.08* by the Kruskal-Wallis test), were more likely to be hospitalized (odds ratio, 1.9; 95 percent confidence interval, 0.95 to 3.9; *P = 0.07*), and were less likely to have a recurrence of diarrhea after at least two days of normal stools (odds ratio, 0.5; 95 percent confidence interval, 0.2 to 1.1; *P = 0.05*).

Clinical Cryptosporidium Infection in the MWW Service Area

Of the 182 respondents to the telephone survey of the MWW service area, 229 (49 percent) reported having had diarrhea since March 1, 1993; 201 of the 229 (88 percent) had watery diarrhea and thus met our case definition of clinical cryptosporidiosis. The mean age of the people with clinical cryptosporidiosis was 45 years (range, 18 to 84), and 138 (60 percent) were women. The rate of watery diarrhea was similar among men and women. Table 1 shows the clinical characteristics of the people with clinical cryptosporidiosis, as compared with those of the people with laboratory-confirmed cryptosporidiosis infection. Those with laboratory-confirmed infection had a significantly longer duration of diarrhea and more stool per day; the frequency of fever, fatigue, nausea, vomiting, and loss of appetite was also higher in this group. Among people with clinical cryptosporidiosis, the median duration of watery diarrhea was 3 days (range, 1 to 30), with a median reported maximum of 5 stools per day (range, 1 to 60). Among people with fever, the median reported maximum temperature was 37.7°C (range, 37.2 to 40.0°C). Thirteen people with clinical cryptosporidiosis (5.5 percent) reported having visited a physician because of their illness. The dates of the onset of illness in those with clinical cryptosporidiosis infection are shown in Figure 2, lower panel.

Survey of Households in the Greater Milwaukee Area

 interviewing was completed by 613 of the 840 households that were contacted (73 percent). The surveyed households were very similar to the 601,438 households reported in the 1990 Census, in terms of the age, and geographic distributions of people in the greater Milwaukee area and the number of members per household. Among the 1653 households, members surveyed, 493 (30 percent) were reported to have had diarrhea beginning during the period from March 1 through April 28, 1993, and in 436 the diarrhea was characterized as watery. Among these 436 people, the median duration of diarrhea was 3 days (range, 1 to 43). The occurrence of diarrhea among survey participants peaked from April 3 through April 5, and by April 16 it had decreased to the level before the out-

![Figure 2. Reported Date of the Onset of Illness in Cases of Laboratory-Confirmed or Clinically Defined Cryptosporidium Infection during the Period from March 1 through April 15, 1993.](image)

The clinically defined cases were identified during a telephone survey begun on April 9 of residents in the area served by the Milwaukee Water Works.
break (Fig. 3). The attack rate was similar for males and females and was highest among household members who were 30 to 39 years of age (Table 2).

The rate of watery diarrhea was highest among the residents of the MWW southern region (52 percent), less high in the middle zone (33 percent) and northern region (26 percent), and lowest outside the MWW service area (15 percent) (Table 2). The risk of watery diarrhea was highest among residents of the MWW service area than among residents of areas outside the MWW region (relative risk, 2.7; 95 percent confidence interval, 2.2 to 3.2; P < 0.001). As compared with the risk of watery diarrhea among people living outside the MWW service area, the risk was more than three times higher among residents of the MWW southern region (relative risk, 3.6; 95 percent confidence interval, 3.0 to 4.3; P < 0.001) more than two times higher among those in the middle zone (relative risk, 2.4; 95 percent confidence interval, 1.8 to 3.3; P < 0.001), and almost two times higher among those in the northern region (relative risk, 1.8; 95 percent confidence interval, 1.3 to 2.3; P < 0.001).

Among the 644 people who resided outside the MWW service area and worked outside the home, 14 of the 28 (50 percent) who worked in the southern region had watery diarrhea. When compared with 96 of the 618 (15 percent) who worked outside the southern region (relative risk, 2.6; 95 percent confidence interval, 1.6 to 4.2; P = 0.002).

Estimate of the Magnitude of the Outbreak

By applying the rate of watery diarrhea among the survey participants (26 percent) to the total population of the greater Milwaukee area (1,610,000 people), we estimated that 419,000 people (95 percent confidence interval, 385,000 to 451,000) in this area had watery diarrhea during the survey period. Using a background rate of 0.5 percent per month for cases of watery diarrhea among residents, we estimated that 16,000 cases of watery diarrhea unrelated to the waterborne outbreak could have been expected during March and April 1993 (unpublished data). Thus, an estimated 403,000 people had watery diarrhea that could be attributed to this outbreak.

Discussion

A massive outbreak of waterborne cryptosporidium infection occurred in the greater Milwaukee area during March and early April 1993. More than 400,000 people were affected during this outbreak. However, by limiting the case definition to watery diarrhea in our survey, we may have underestimated the size of the affected population. Cryptosporidium infection was confirmed in more than 600 people with gastrointestinal illness in association with this outbreak, and despite intensive investigation, no other enteric pathogen could be found to account for the illness.

More than half the people who received residential drinking water predominantly from the MWW's southern water-treatment plant became ill, which was twice the rate of illness among people whose residential drinking water came mainly from the MWW's northern water-treatment plant. The intermediate attack rate among residents of the middle zone was unexpected, since the MWW distribution system, adjusting for variations in flow, would have intermittently allowed water from the southern plant to reach their residences. Diarrhea among people not living in the MWW service area may have resulted from consumption of water while they were working in or visiting the area. Among nursing home residents in the northern region, who were unlikely to travel, there was no increase in diarrheal illness associated with the outbreak.

Table 2. Rate of Watery Diarrhea from March 1 through April 28, 1993, among Respondents in a Random-Digit Telephone Survey of Households in the Greater Milwaukee Area, According to Sex, Age, and Water Works Region.

<table>
<thead>
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<td>56</td>
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<tr>
<td>Northern</td>
<td>312</td>
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<td>26</td>
</tr>
<tr>
<td>Non-MWW</td>
<td>977</td>
<td>272</td>
<td>15</td>
</tr>
</tbody>
</table>


break, whereas among nursing home residents in the southern region, there was a marked increase in the prevalence of diarrhea (unpublished data).

Our findings demonstrate a wide range in the duration and severity of illness caused by cryptosporidium infection. As expected, people with laboratory-confirmed cryptosporidium had diarrhea of significantly longer duration and more frequent bowel movements, vomiting, fever, and fatigue than those with non-laboratory-confirmed cryptosporidium, who were identified through the telephone survey. The epidemiologic features and dates of onset of illness among the people with laboratory-confirmed cryptosporidium infection were similar to those among the people interviewed by telephone who reported having watery diarrhea, supporting our hypothesis that the latter group had clinical cryptosporidiosis.

Despite communitywide increases in diarrheal illness in Milwaukee, the recognition of cryptosporidium infection as the cause of this outbreak was delayed for several reasons. The constellation of gastrointestinal symptoms (e.g., diarrhea, abdominal cramping, and nausea) and constitutional signs and symptoms (e.g., fatigue, low-grade fever, muscle aches, and headache) reported by Milwaukee-area residents led many physicians to diagnose viral gastroenteritis or "intestinal flu" without further investigation. Our findings suggest that people with diarrheal illness seek health care infrequently; do so only when the illness is severe or prolonged, and are unlikely to be tested for cryptosporidium infection. Unlike the detection of other intestinal parasites, which are identified by means of a standard examination for ova and parasites, the detection of cryptosporidium requires specialized testing. Infrequent testing for cryptosporidium in patients with diarrhea may be due to misconceptions about the incidence and severity of this infection among immunocompetent patients. A large, multicenter, laboratory-based study of patients with acute gastrointestinal illness in England found that infection with cryptosporidium was almost as common as salmonella infection and nearly three times more common than shigellosis. Although physicians may question the value of testing when infection is self-limited in immunocompetent hosts and an effective treatment is available, testing allows the education of patients, facilitates the recognition of an outbreak, and may lead to the institution of measures to prevent its spread.

In the Milwaukee outbreak, cryptosporidium oocysts in untreated water from Lake Michigan apparently entered the southern water-treatment plant and were then inadequately removed by the coagulation and filtration process. Cryptosporidium oocysts have often been found in untreated surface water used for public water supplies in the United States. The source of the oocysts leading to the outbreak in Milwaukee and the timing of their entrance into the Lake Michigan remain speculation. Possible sources include cattle along two rivers that flow into the Milwaukee harbor, slaughterhouses, and human sewage. Rivers that were silted by spring rains and snowmelt may have transported oocysts into Lake Michigan and from there to the intake of the MWW southern plant.

As in previous cryptosporidium outbreaks in the United States associated with filtered water supplies, water-quality measurements at the MWW southern plant were within the required limits; however, unlike the plants involved in the previous outbreaks, the MWW plant had no evident mechanical breakdown of its coagulants or filters. The reason for the plants' failure to maintain treated water at low turbidity is unclear and continues to be investigated. Difficulty in determining the appropriate amount of polycationic chloride and alum may have been a contributing factor in the failure to maintain low turbidity; the MWW plant recently reinstated the streaming-current monitor, which now aids in determining the amount of coagulant. The recycling of filter backwash water may increase the concentration of oocysts in water passing through filters; therefore, this practice has been discontinued. Decreased turbidity and removal of particles under 15 μm in diameter from water have been shown to correlate significantly with the detection of cryptosporidium in water. The MWW therefore has installed continuous turbidity monitors on each filter bed, with an alarm/sounder and the system automatically shut down if the turbidity of filtered water exceeds 0.3 NTU, and has instituted frequent measurement of particles in untreated and treated water.

Because some visitors to the MWW service area, who drank very small amounts of water (~240 ml [8 oz]) had laboratory-confirmed cryptosporidiosis (unpublished data), the peak concentration of oocysts in the water probably far exceeded one oocyst per liter. Thus, we believe the cryptosporidium oocysts found in the treated ice vastly underestimated the peak level in water from the southern plant. The lower-than-expected concentration of oocysts may have been due to the timing of the specimen collection (i.e., the freezing of ice blocks), the freezing process, and insensitivity of testing procedures.

The number of both laboratory-confirmed and clinically defined cases of cryptosporidium infection with an onset of illness before March 23, when the turbidity of treated water increased, was higher than expected, suggesting that cryptosporidium oocysts had entered the water supply before the increase in turbidity was apparent. This occurrence would not be without precedent. In England a waterborne outbreak of cryptosporidium infection associated with a filtered water supply occurred while the turbidity of treated water remained less than 0.5 NTU. Surveillance in the United Kingdom has discovered sudden, irregular, communitywide increases in cryptosporidiosis that were unlikely to have been transmitted by the fecal-oral route, suggesting that some sporadic cases of cryptosporidiosis may be waterborne.

Cryptosporidiosis is an underdiagnosed condition,
and outbreaks are likely to be underestimated. Our findings have implications for standards of water quality, public health surveillance, and recognition of cryptosporidium outbreaks in the United States. Until an inexpensive, rapid, and sensitive means of detecting and quantifying cryptosporidium in treated water is available, we believe that water-treatment-plants should consider instituting continuous monitoring of treated water for turbidity, particularly of filter effluent, and particle size. Plant design and water-treatment procedures should be improved to maintain the quality of treated water at a level that will make the presence of oocysts unlikely (e.g., a goal of turbidity ≤0.1 NPU). We recommend that clinicians and laboratorists consider performing routine stool tests for cryptosporidium in patients with watery diarrhea and that public health officials make cryptosporidium infection a reportable condition. In the United Kingdom, water and health officials have already developed an extensive strategy to investigate the clinical importance of cryptosporidium found in water supplies. Intensive efforts and cooperation between the medical community and those who provide and regulate drinking water in the United States will be required to prevent future waterborne outbreaks caused by this emerging pathogen and to ensure the safety of drinking water for all citizens.

We are indebted to the following people for their contributions to this study: Walter Powers, A.J. Henry, and Richard R. Regen, Milwaukee Water Works; the infection-control practitioners at participating nursing-homes and hospitals in the Milwaukee area; the directors and parasitologists at the 14 participating clinical laboratories in the Milwaukee vicinity; Hn, John Neufang, medical director of the City of Milwaukee; Paul Nortin, director, Thomas Schreiber, M.D., and the staff of the Milwaukee Health Department; Wendy L. Schell, M.A., Helen North, M.D., Jack Marzol, M.D., John Chapman, Jean Lay, and Ann Harter, Wisconsin Division of Health; Ben Turkus and the staff of the Milwaukee STD Program; Carol Graham, M.D., and the volunteers public health workers of the Greater Milwaukee area; Gerald Sedlak, Ph.D., Ajmal Singh, Ph.D., and the staff of the Milwaukee Bureau of Laboratories; Paul Befeler, and the staff of the Environmental Health Section, Milwaukee Health Department; Dennis Janke, V.M.D., Division of Animal Diseases, Center for Infection Diseases; Roger Glass, M.D., M.P.H., Ph.D., Stephen M. Mann, M.D., Charles Humphries, Ph.D., and Sara Steiner, Centers for Disease and Prevention (CDC) Viral Gastroenteritis Laboratory; Margaret Hard and the staff of the CDC Parasitology Laboratory; the staff of the Wisconsin State Laboratory of Hygiene; the staff of the Survey Research Laboratory, University of Wisconsin Extension: Darren Layle, P.E., U.S. Environmental Protection Agency; and Ava Nadin, Epidemiology Program Office, CDC.

REFERENCES

Increased Exposure to Cryptosporidia among Dairy Farmers in Wisconsin

Eugene J. Lengerich,† David G. Addiss, James J. Marx, Beth L. P. Ugar, and Dennis D. Juranek

Cryptosporidium infection is an important cause of diarrhea in humans and livestock; no effective therapy is known. A self-administered questionnaire and an ELISA were used to assess the risk of exposure to cryptosporidia among 70 dairy farmers and 50 who were not dairy farmers in Wisconsin. Dairy farmers (44.3%) were more likely to be seropositive for cryptosporidia than were other persons (24.0%; relative risk = 1.9). Among dairy farmers, age ≥50 and use of a canister method of milking were associated with seropositive status. Among persons who were not dairy farmers, feeding or milking cows was associated with being seropositive. These findings suggest that dairy farmers and other persons who have contact with cattle are at greater risk of Cryptosporidium infection than are persons who do not have such contact. Identification and avoidance of farming practices associated with Cryptosporidium infection may reduce the risk of infection among dairy farmers.

Cryptosporidium parvum is a coccidian parasite that can cause chronic, life-threatening diarrhea in immunocompromised persons and self-limited diarrhea in immunocompetent persons [1, 2]. Effective therapeutic or prophylactic agents have not been developed. While oocysts have been found in the stools of <5% of symptomatic persons examined in the United States [2], estimates of seroprevalence in the United States have been much higher, ranging from 17% to 35% [4–6].

Livestock, including cattle, can also become infected with cryptosporidia. Infection of young dairy calves with cryptosporidia typically causes self-limited diarrhea but has been associated with intractable diarrhea and death [1, 2]. Studies in California [7], Maryland [8], and Idaho [9] found that 5%–39% of dairy calves had oocysts in their stools. Each year in the United States, an estimated $6.2 million is lost from cryptosporidiosis in calves [2].

Cattle have been implicated as a source of human cryptosporidiosis. Infection among rural persons in Finland [10] and Israel [11] and animal handlers in the United States [1] has been associated with cattle. Infected cattle may also contribute to waterborne outbreaks of cryptosporidiosis [6]. Person-to-person transmission [4, 11] may subsequently increase the number of human infections.

While these reports have documented isolated incidents associated with infected livestock, no studies have evaluated the risk for persons in the United States who have frequent contact with potentially infected animals, such as dairy farmers, and who may thus be at increased risk of exposure to cryptosporidia. We studied a cohort of persons in central Wisconsin to estimate the seroprevalence of Cryptosporidium infection among persons in this agricultural area to determine if persons with frequent exposure to cattle are at increased risk for Cryptosporidium infection and to identify demographic and behavioral characteristics associated with exposure.

Methods

Marshfield is an agricultural, principally dairy, community in north-central Wisconsin. In 1975, 2097 persons living or working on randomly selected farms in the Marshfield area were asked to participate in a longitudinal study of respiratory disease at the Marshfield Medical Research Foundation: 72% agreed [12]. Fifty-eight percent were male and 98% white. Identified from the original cohort by their serologic reactivity to antigens associated with farmer’s lung disease, 115 farmers consented to participate in a longitudinal study of respiratory disease and the present study, conducted in 1990. Sixteen nonfarming participants were volunteers from employees of the Marshfield Clinic Demographic, occupational, and farm information were obtained by a self-administered questionnaire. All participants were classified according to their reported farming status; current farmers, ex-farmers, and never farmers. Ex-farmers were persons who reported having quit farming since being enrolled in the original study in 1975. The 16 participants from the Marshfield Clinic who were considered never farmers, had never been employed on a farm, and 6 had never had any farm experience (e.g., helping with hay-making). For the other 10, the median time since any farming experience was 26 years (range, 12–47).

Received 6 March 1992; revised 23 November 1992.

Grant supported by: National Institutes of Health (HL-37121); Marshfield Medical Research Foundation.

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†Present affiliation: Division of Adult Health, North Carolina Department of Environment, Health and Natural Resources, Raleigh (R.I.L.); Division of AIDS/Office of the Director, National Institute of Allergy and Infectious Diseases, Rockville, Maryland (R.I.L.P.U.).

The Journal of Infectious Diseases 1993;167:250-5
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0022-1899/93 $06.50/0.00
An ELISA [13] was used to determine the presence of IgG antibodies to cryptosporidia in serum samples collected at the time the questionnaire was completed. The sensitivity and specificity of this assay compared with stool examination have each been reported to be 95% [13]. In univariate statistical analysis, we calculated the relative risk (RR) of being seropositive to cryptosporidia for various exposures. SE and 95% confidence intervals (CI) for each RR were calculated [14]. If we were unable to calculate an RR because unexposed persons were seronegative, the difference in proportions was tested with the Mantel-Haenszel $\chi^2$ test ($P < .05$) [14]. Linear trends in proportions were assessed by the $\chi^2$ test for trend ($P < .05$) [14]. Finally, factors that were significant ($P < .05$) in univariate analysis were examined with logistic regression to examine their independence: odds ratios (OR) and SE were calculated [15].

### Results

#### Characteristics of Participants

Serologic test results from participants were indeterminate and were excluded from analysis. All 11 individuals were current farmers or ex-farmers, 8 (72.7%) were dairy farmers (7 current farmers), 3 (27.3%) were not dairy farmers (1 current farmer). Of the remaining 120 participants, 102 (85.0%) were male, 104 (86.7%) were born in Wisconsin. All were white. Median age was 52 years (range, 28–78). Of all 120 participants, 74 (61.7%) were current farmers, 30 (25.0%) ex-farmers, and 16 (13.3%) were never farmers. A total of 50 individuals (7.3%) were dairy farmers (64 current farmers 35 ex-farmers) while 50 (32.5%) were not dairy farmers. Dairy farmers, the average number of cattle milked was while the average number of acres farmed was 289.

Participants. Among the 120 participants, 43 (35.8%) were seropositive for cryptosporidia. Dairy farming (RR = 95% CI, 1.1–3.2) was associated with seropositive status. Gender, age, education, and number of years in Wisconsin were not associated (table 1). Thirty-one current farmers (41.2%) were seropositive, compared with 9 ex-farmers (30.0%) and 3 never farmers (18.8%) (linear trend, $P = .06$). Compared with never farmers, current farmers and ex-farmers were 2.2 (95% CI, 0.8–6.4) and 1.6 (95% CI, 0.5–5.1) times more likely to be seropositive, respectively. Among ex-farmers, the length of time since leaving farming ranged from <1 year ($n = 1$) to >5 years ($n = 17$) and was not significantly associated with serologic status.

#### Dairy Farmers

Of the 70 dairy farmers, 31 (44.3%) were seropositive for cryptosporidia. Persons >50 years of age had a 90% greater risk of being seropositive than did persons <50 years of age (RR = 1.9; 95% CI, 1.1–3.3) (table 2). Dairy farmers who reported using a canister method of milking had almost twice the risk of being seropositive as did farmers who used pipeline milking (RR = 1.9; 95% CI, 1.2–3.2). Dairy farmers who had been farming >25 years, milked >50 cows, or only fed animals inside were more likely to be seropositive than were farmers who had been farming for <25 years, milked >50 cows, or fed animals outside as well as inside, respectively; however, these associations were not statistically significant. In logistic regression analysis with age and method of milking as independent variables, being >50 years of age was associated with seropositive status (OR = 3.3; 95% CI, 1.2–9.0); the association with using a canister method of milking was not statistically significant (OR = 2.8; 95% CI, 1.0–8.0).
Table 2. Relative risks for exposure to cryptosporidiosis, dairy farmers, Marshfield, Wisconsin, 1990.

<table>
<thead>
<tr>
<th></th>
<th>Positive (n = 31)</th>
<th>Negative (n = 39)</th>
<th>Relative risk (95% CI)</th>
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<tr>
<td><strong>Sex</strong></td>
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<tr>
<td>Male</td>
<td>27</td>
<td>34</td>
<td>1.0 (0.5-2.2)</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>5</td>
<td>—</td>
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<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥50</td>
<td>19</td>
<td>13</td>
<td>1.9 (1.1-3.3)</td>
</tr>
<tr>
<td>&lt;50</td>
<td>12</td>
<td>26</td>
<td>—</td>
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<tr>
<td><strong>High school education</strong></td>
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<tr>
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<td>8</td>
<td>9</td>
<td>1.1 (0.4-2.0)</td>
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<tr>
<td>Yes</td>
<td>23</td>
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<tr>
<td><strong>Time farming</strong></td>
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<td></td>
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<tr>
<td>≥25 years</td>
<td>21</td>
<td>21</td>
<td>1.4 (0.6-2.5)</td>
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<tr>
<td>&lt;25 years</td>
<td>10</td>
<td>18</td>
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<tr>
<td><strong>Birthplace</strong></td>
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<tr>
<td>Wisconsin</td>
<td>29</td>
<td>35</td>
<td>0.8 (0.2-2.4)</td>
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<td><strong>Milking method</strong></td>
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<tr>
<td>Canister</td>
<td>14</td>
<td>7</td>
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<tr>
<td>Pipeline</td>
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<tr>
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<tr>
<td>&lt;50</td>
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<td>21</td>
<td>—</td>
</tr>
<tr>
<td><strong>Feeding location</strong></td>
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<tr>
<td>Inside calf</td>
<td>19</td>
<td>19</td>
<td>1.4 (0.8-2.6)</td>
</tr>
<tr>
<td>Inside and outside</td>
<td>9</td>
<td>16</td>
<td>—</td>
</tr>
</tbody>
</table>

NOTE. Farmers includes current farmers or ex-farmers (n = 78). CI, confidence interval. * The cells do not add up to 70 because of missing values.

**Persons who were not dairy farmers.** Among the 50 persons who were not dairy farmers, 12 (24.0%) were seropositive for cryptosporidiosis. Twelve (30%) of 40 persons born in Wisconsin were seropositive, compared with 0 of 10 born elsewhere (P = .04). Among persons who were not dairy farmers, the percentage that were seropositive varied inconsistently with age. Three of 5 persons who reported currently milking or feeding cows (e.g., on a hobby farm) were seropositive, while 9 (20%) of 45 who reported no such activity were seropositive (RR = 2.9; 95% CI, 1.2-7.6). In logistic regression analysis, neither of the independent variables, birthplace in Wisconsin and currently milking or feeding cows, was significantly associated with being seropositive.

**Discussion**

In this study, the risk of being seropositive for cryptosporidiosis was ~1.9 times higher for dairy farmers than for other persons. This finding, along with a suggestion of increased risk for persons who fed or milked cows even though they were not dairy farmers, supports our hypothesis that frequent exposure to cattle is associated with increased risk of Cryptosporidium infection.

Overall, 35% of study participants were seropositive for cryptosporidiosis; this is within the range (17%-35%) of seroprevalence estimates from other studies in the United States [4-6]. Our estimate of seroprevalence in Marshfield may be at the upper limit of age (58.3%) of dairy farmers in our sample population. The seroprevalence among persons in this study who were not dairy farmers (24.0%) is more centrally located within this range of estimates.

Among dairy farmers, the percentage who were seropositive increased with age; among other persons, this association was not observed. These findings suggest two hypotheses. First, older dairy farmers may have had a history of more intense, prolonged, or frequent exposure to cryptosporidiosis (independent of farming practices) than was experienced by younger dairy farmers. We are unable to adequately address this hypothesis because detailed lifetime exposure histories were not assessed and the rate at which anti-cryptosporidial antibody decays between exposures or in the absence of re-exposure is unknown.

Alternatively, older dairy farmers may be more likely to engage in specific farming practices that increase the risk of exposure to cryptosporidiosis than are younger dairy farmers. Although not associated with age in this study, one such practice, using a canister method of milking, was associated with exposure in univariate analysis. Other potential high-risk practices that were not measured, such as the use of group housing for young calves [2], may be more common among older farmers.

Inconclusive serologic results have previously been associated with intermittent or low-level exposure to cryptosporidiosis [13]. If such were the case in this study, we may have underestimated the risk of exposure associated with dairy farming since we excluded the 11 participants with an indeterminate result. Eight (72.7%) of these 11 were dairy farmers, and 7 of the 3 who were not dairy farmers reported currently milking or feeding cattle.

Our study has several limitations. As is possible with all studies that rely on self-reported exposure, the ability to recall specific exposures may have differed between persons who were seropositive and those who were seronegative. However, we consider it unlikely that recall bias was a substantial problem because the questionnaire focused on exposures for respiratory rather than gastrointestinal disease.

The results may not be generalizable to other farmers because the original sample was drawn from a limited geographic area. In addition, the farmers in this study were not entirely representative of the original, randomly selected sample. Although the original sample and the farmers in this study were similar by race, mean age of the original sample (in 1975) was 41 years compared with 51 years for farmers in the current study (in 1990). Males made up 58% of the original sample compared with 85% of farmers in this study; however, we did not find gender to be associated with serologic status.
because we used available data from a 15-year cohort study that was intended to assess the risk for selected respiratory diseases among farmers, we were unable to adequately address several possible confounding factors. These factors could include the presence and number of calves on the farm, the prevalence of infection among calves, and the frequency and duration of farmer contact with calves. Though height of time as a farmer was measured, its effect was difficult to assess in this study because of its high degree of correlation with age. We were also unable to assess the existence of other non-farm-related exposures to cryptosporidia, including drinking water [6] and the presence in the household of children who attend day care centers [2].

Despite these limitations, we found that dairy farmers were at higher risk of exposure to cryptosporidia than were other persons in this study. Additional work is needed to identify specific farming practices that may elevate this risk, to determine the risk of secondary transmission of farm-acquired infection to family members and other close contacts, and to define the morbidity associated with such transmission. Identification of high-risk farming practices could lead to the development of recommendations and strategies to interrupt transmission of cryptosporidia to humans and reduce cryptosporidia-associated morbidity and mortality among calves and the resulting economic toll.

References

SUPERIOR COURT OF THE STATE OF CALIFORNIA
COUNTY OF SAN DIEGO

SAVE OUR FOREST AND RANCHLANDS, a California Corporation,

Plaintiff,

v.

COUNTY OF SAN DIEGO, a governmental entity; the BOARD OF SUPERVISORS OF THE COUNTY OF SAN DIEGO, AND DOES 1-15,

Respondents.

Case No.: No. 676630
Statement of Decision
Hon. Judith D. McConnell
Department 75

This matter came on regularly for hearing on August 28, 2000 in Department 75 of the Superior Court, in and for the County of San Diego, the Honorable Judith D. McConnell, Judge presiding.

Plaintiff, Save Our Forest and Ranchlands (SOFOR) appeared by and through counsel Charles Stevens.

Respondent County of San Diego appeared by and through Senior Deputy County Counsel, Laurie J. Orange, and Mark Mead. The Farm Bureau, Amicus Curiae, appeared by Attorney Henry E. Rodegerdts. The People of the State of California, Amicus Curiae, appeared by and through Deputy Attorney General Susan Durbin. Briefs were filed on behalf of the following Amici Curiae: California Native Plant Society, California Oak Foundation, Center for Biological Diversity, Environmental Health Coalition, Mountain Defense League, San Diego Audubon Society, San Diego Baykeeper, Sierra Club, and Surfrider Foundation, by Daniel P. Seimel, Esq.
Before the Court was the County's Motion to Discharge the Peremptory Writ of Mandate.

BACKGROUND

In 1994, the County amended the land use element of its general plan to establish a uniform eight-acre minimum parcel size throughout its agricultural preserves. No EIR was prepared on the project. SOFAR filed a Petition for Writ of Mandate, challenging the adequacy of the County's general plan regarding agricultural issues, and arguing, among other things, that eight-acre parcels are too small to support viable agricultural uses. This court granted the Petition and issued a peremptory writ of mandate requiring the County to vacate its general plan amendment, bring the land use, conservation and open space elements of the general plan into conformance with the law, and to prepare an Environmental Impact Report (EIR) on the project.

In response, the County prepared and adopted General Plan Amendment (GPA) 96-03. The project amends the Land Use Element of the San Diego County General Plan to establish minimum acreage designations for properties located in a 191,000-acre area of San Diego County, ostensibly set aside for agricultural uses. Additionally, the County adopted rezoning implementation, an issue area lands within an area designated "(20)" on the General Plan.

Under GPA 96-03, the (20) lands west of the County Water Authority (CWA) boundary would have a density of one dwelling per ten acres; East of the CWA boundary, the (20) lands would have a density of one dwelling per 40 acres. The County prepared an Environmental Impact Report (EIR) which predicts significant environmental project and cumulative impacts on the (20) lands. The County deemed nearly all such impacts unsalvable. To the extent that any such impacts were mitigable, the mitigation measures were deemed unfeasible.

When presented with the original proposal, the County Planning Commission deadlocked on the matter, referring it to the County Board of Supervisors. The Board of Supervisors adopted GPA 96-03.

1 Paragraph 6 of the final judgment and paragraph D.2.e of the Peremptory Writ of Mandate were reversed on appeal. The judgment was otherwise affirmed. (D025782), Feb 4, 1997.
with two abstentions. The County now seeks to discharge the Writ; SOFAR opposes discharge of the Writ and seeks to have the court set aside the adoption of GPA 96-03, and its implementing resolution.

The Land

The area affected by GPA 96-03 is a vast expanse of acreage scattered across an extraordinarily diverse part of Southwestern California. It is a land of great contrasts. It ranges from chaparral, to Diegan Coastal Sage scrub, from oak woodland, to forests, from areas of coastal influence, to desert ecosystems. [AR 20]. In an area flush with "sensitive, rare, threatened or endangered species of both plants, and animals." [AR 151]. Sensitive flora and fauna in San Diego County are found, or "expected to be found", in astonishing array.

Thus, in the aggregate, the (20) lands form an inconspicuous, and numerous zoological and botanical zone.

In contrast to the suspected abundance of flora and fauna, there are two things in apparent short supply in this area earmarked for agricultural development: 1) good soil and, 2) unimported, and, therefore, inexpensive water. [AR 101, 103, 116-217. Report and Supplemental Report of William W. Wood, Jr.]

Agriculture in San Diego and (20) Lands

County contends that GPA 96-03 will foster agriculture in San Diego County. Agriculture is an important aspect of the local economy. From a strictly economic viewpoint, San Diego agriculture is lesser a broad basket than it is a flower basket. The single most valuable crop produced in San Diego County in 1997 was "indoor decoratives", at a value of $287,568,250. Bedding plants and turf were next at $131,282,000. Together they comprised 62% of the economic output of San Diego agriculture in the year surveyed. [AR 374-375]. One apparent reason for this is that it is possible to make more money per acre with such nursery crops. [AR 327]. This is despite the fact that they are considered water intensive crops. [AR 101]. Avocados are the third most valuable crop in San Diego County. Eggs, milk, and other products of animal agriculture are also produced.
Oddly, as the County points out, much of the lands in the (20) area are "not suitable for agriculture due to lack of water, good soil and appropriate topography". County's Reply, page 9, fn. 7.

However, the County hopes that GPA 96-03 will nonetheless encourage agriculture in the area.

The Farm Bureau agrees that GPA 96-03 will promote the purposes of agriculture in San Diego County. The Farm Bureau believes that an "ag-urban" mix of land uses can serve as a "test-tube crucible to show the balance of the state how agriculture can survive and thrive". The Farm Bureau asserts that the key to this is smaller "farms", which San Diego has in abundance. So convinced is it of the efficacy of the agriculture model established by GPA 96-03, the Bureau states that "if California is to continue to be the California we know today, then what we see in San Diego County must be superimposed over the balance of this state." [Brief of Amicus Curiae Farm Bureau, p. 4].

Others are skeptical of the contention that GPA 96-03 is intended to promote agriculture. The concern is that the unexpressed purpose of the plan is to promote a patchwork of residential development in the form of ranchettes, and that these ranchettes will soon be transformed into suburbs. [AR 1197, 1218, 1218].

The Standard of Review

In reviewing a matter subject to the California Environmental Quality Act (CEQA), the court determines whether the Lead Agency prejudicially abused its discretion by failing to proceed in a manner required by law or by reaching a decision which is not supported by substantial evidence. Public Resources Code § 21168.5; Blum v. Imperial Improvement Association v. Regents of the University of California (1982) 47 Cal.3d 376; Western States Petroleum Ass'n v. Superior Court (1995) 9 Cal.4th 559, 567-568.

Whether the EIR Conforms to the Requirements of CEQA

The court has previously determined that an EIR on the project is required. The County has complied with the letter, if not the spirit, of this aspect of the Writ of Mandate. The question is whether the EIR meets the intended purpose of such a report.
"The EIR is the primary means of achieving the Legislature's considered declaration that it is the policy of this state to take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state. [Public Resources Code § 21001(a)] The EIR is therefore 'the heart of CEQA.' [Guidelines, Cal. Code of Regs., tit. 14, § 15003(a)]; County of Inyo v. Vesty (1973) 32 Cal.App.3d 795, 810.] An EIR is an 'environmental alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return.' [Santiago County Water Dist. v. County of Orange (1981) 118 Cal.App.3d 816, 827.]

Laurel Heights Improvement Ass'n v. Regents of the University of Cal. (1988) 47 Cal.3d 176, 382.

The crux of the matter is whether GPA 96-03 brings us to an ecological point of no return. The County contends that it does not and that there will be further opportunities for review. The County contends that when "specific discretionary projects are proposed, such as subdivisions and tentative maps, these projects will receive environmental review". Motion, County, p. 13. Thus, the County takes the view that GPA 96-03 is merely a General Plan amendment, and that, as a result, a deeper level of environmental analysis is not required at this time.

In this case, the Court finds that an environmental review deficiency is an environmental review deficiency. The EIR points out that agricultural lands are exempt from the County's grading ordinance and that, theoretically, all of these lands could be cleared and graded without further environmental review. [AR 151-152]. In that event, "there could be 1) significant secondary impacts to most distinguishable vegetation communities and natural habitats on a countywide basis, 2) significant secondary impacts to vegetation communities and habitats in all Community and Subregional Planning Areas and 3) significant cumulative impacts to wildlife corridors within the project areas." [AR 152].
"Agricultural practices (such as) distancing, plowing, planting, irrigation, harvesting, and grazing are generally allowed by right in the (19) and (20) areas. Erection of agricultural buildings requires only a ministerial building permit and does not undergo environmental review. Expansion of agricultural operations into vacant land supporting native wildlife habitat requires no discretionary review or permit outside of the MSCP Subarea due to specific exemptions given to agriculture" [AR 140]. In other words, as a worst case scenario, all sensitive flora, and habitat for creatures great and small in the (20) area could be plowed under, without further review. This would seem to be the environmental point of no return.

This situation should be contrasted with that described in Rio Vista Farm Bureau Center v. County of Solano (1992) 5 Cal.App.4th 351 and Al Larson Boat Shop v. B4 of Harbor Commissioners (1993) 18 Cal.App.4th 729, where further environmental review was contemplated. Here, although the County suggests that subdivision of the (20) lands will be subject to environmental review, there may be no flora or fauna left to review should this speculative future review actually occur.

Thus, it is insufficient to state that there could be effects on groundwater, on surface water, on rare and protected species of plants and animals. "What is needed is some information on how adverse the adverse impact will be." Santiago County Water District v. County of Orange (1981) 118 Cal.App.3d 118, 131. As stated in Santiago, "An EIR should be prepared with a sufficient degree of analysis to provide decision-makers with information which enables them to make a decision which intelligently takes account of environmental consequences." Guidelines, Cal. Code of Regs., tit. 14, §15120. See, Stanislaus Natural Heritage Project v. County of Stanislaus (1996) 48 Cal. App. 4th 182.

Here, the Board of Supervisors was merely reliant on the EIR for information sufficient for it to take into account environmental consequences. The Supervisors were deprived of this information. The EIR should spell out just how adverse the project will be on the zoology and the botany of the region.

The Attorney General points out that the EIR merely contains a table of the wildlife species that have
been found or are "expected to be found" in the (20) lands. It is one thing to say that certain animals on a
long list may be affected; it is another to say that unbridled grading of parcels within a particular area
will necessarily lead to the extinction of particular species. San Diego County may decide that it needs
more farms producing "indoor decorative" with imported water, and fewer native animals and plants. It
is to elected officials to make that call, provided they have otherwise complied with CEQA. However,
compliance with CEQA requires better information than that presented here.

It is not required that the County visit each of the proposed (20) parcels and individually
examine the impact of the project. What is required is that the County make a good faith effort to go
afoot and afield in San Diego and come back with a reasonable assessment of what the County stands to
lose as a result of the project. Guidelines, Cal. Code Regs. tit. 14, § 15151. "The fact that precision is not
possible...does not mean that no analysis is required". Laurel Heights, supra, at 309.

It has been said—and sung—that "you don't know what you've got 'til it's gone". Yet where
CEQA applies, the opposite is true: Citizens and decision makers must, in fact, be informed of what
they have before, and not after, it is gone. While the environmental effects of GPA 96-03 are unknown,
they are not, as the County insists, unknowable. Although the area covered by the (20) lands is vast, the
County need not examine each parcel. Approximately 25% of the affected lands are in public
ownership. [AR 1857]. At least half of the (20) lands have been deemed by the County to be unsuited
for intensive agriculture. [AR 2081]. Thus, the County is not obliged to visit every acre in the (20)
lands. Rather, it should prepare a focused analysis on lands that the County can reasonably expect to be
impacted by GPA 96-03. "Drafting an EIR or preparing a negative declaration necessarily involves some
degree of forecasting. While foreseeing the unforeseeable is not possible, an agency must use its best

efforts to find out and disclose all that is reasonably can." Guidelines, Cal. Code of Regs., tit. 14, § 15144.5.

Where, as here, important, detailed and relevant information is missing, it precludes informed decision making and a prejudicial abuse of discretion results. Kings County Farm Bureau v. City of Hanford (1990) 221 Cal.App.3d 692.

The Failure to Mitigate

Mitigation measures must be developed to minimize, reduce, or avoid identified environmental impact or to rectify or compensate for that impact. Guidelines, Cal. Code of Regs., tit. 14, § 15370. Here, the identification of the impacts is so speculative, vague and unsupported by evidence as to be meaningless, except to inform decision makers that significant environmental impacts in certain broad categories may occur if CPA 95-03 is rezone are implemented. As noted above, this is insufficient. Assuming arguendo that such impacts had been adequately identified, the County has nonetheless failed to take the appropriate next step of fully and carefully analyzing mitigation measures.

The County has determined that the benefits of the project outweigh the projected significant effects on the environment and that the mitigation measures proposed are unfeasible. Los Angeles Unified School District v. City of Los Angeles (1997) 56 Cal.App.4th 1019. Here, the County has indicated that the promotion of agriculture in the (20) lands outweighs the additional burdens on traffic, the possible and unmitigated extinction of species, the possible contamination or depletion of ground and surface waters and the host of other significant effects on the environment prognosticated in the EIR. The County proposed, and then dismissed, precisely one measure in mitigation of these effects: a possible amendment of its grading ordinance that would have provided for some review of agricultural grading. It deemed this unfeasible because it could impose expensive site-specific surveys on the small farmer. However, as indicated by SOPAR and the Attorney General, the County failed to consider more tailored proposals such as grading projects above a certain size, grading within a certain distance of streams, lakes, vernal pools or wetlands, or grading which, in the opinion of a building official has a
potential for significant environmental impact. [AR 1784]. The County had before it numerous examples of agricultural grading ordinances, such as that of Lake County.

It is not the province of the court to determine which mitigation measures are best, or the most feasible. Los Angeles Unified School District, supra, at 1030. The Lead Agency must make this determination "based on a reasonable balancing of the relevant economic, environmental, social and technological factors". City of Del Mar v. City of San Diego (1982) 133 Cal.App.3d 401, 417. The County appears not to have performed this analysis with respect to the grading ordinance. The conclusion that there is no feasible mitigation measure that would address the problems posed by agricultural grading is simply not supported by substantial evidence.

An EIR is intended to "demonstrate an apprehensive citizenry that the agency has thoroughly analyzed and considered the ecological implications of its action". California Resources Project v. City of Los Angeles (1974) 13 Cal.3d 60; Guidelines, Cal. Code of Regs., Title 14 § 15003(d). In this case, it is plain that the EIR has not fulfilled this legislative intention. The County shall prepare an EIR that fully apprises the citizenry and the Board of Supervisors of the actual adverse effects of the project, so that the appropriate elected officials can make an informed decision as to the wisdom of the project.

The motion to discharge the writ is denied. The County is ordered to prepare a revised EIR which analyzes the biological, botanical and hydrological resources at risk or impacted, if any, by the (20) lands. In so doing, it should be guided by the rule of reason. It may employ resources already available to it, such as Resource Conservation oversees, GIS databases, and recent field studies. Where gaps remain, it should perform targeted research, sufficient to apprise the Board of Supervisors of the environmental impacts of its decisions.

IT IS SO ORDERED.

August 31, 2000

[Signature]

Judith D. McConnell
Judge of the Superior Court

000602
SUPERIOR COURT OF CALIFORNIA, COUNTY OF KERN
METROPOLITAN DIVISION

DATE: Thursday, May 3, 2001

PRESENT: ROGER D. RANDALL, Judge

COURT MET AT: 8:30 a.m.

CLERK: C. L. Isaac

COUNSEL:

CENTER ON RACE, POVERTY & THE ENVIRONMENT, MARIA CRUZ MEDINA, ET AL
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COUNTY OF KERN, BOARD OF SUPERVISORS FOR THE COUNTY OF KERN
-JAMES H. THEBEAU
BORBA DAIRY FARMS, ET AL
Real Parties in Interest

Michael H. Remy, Osha R. Meserve

No. 242336

PETITION FOR WRIT OF MANDAMUS & COMPLAINT FOR DECLARATORY RELIEF HERETOFORE SUBMITTED ON 2/23/01

DISPOSITION:

See copy of ruling attached and made a part hereof.

Copies mailed to counsel on this date./cli

MINUTES

000603
RULING ON CENTER ON RACE, POVERTY & THE ENVIRONMENT, ET AL.
V. COUNTY OF KERN, ET AL.

(Case No. 242336-RDR)

The Court, having read and considered the briefs of the parties, having reviewed the Administrative Record insofar as it is pertinent to the issues presented in this lawsuit, and being informed by the oral arguments of counsel, makes the following rulings:

I.

THE STANDING OF PETITIONERS TO SEEK RELIEF

Respondents raise two issues concerning the standing of Petitioners. First, they argue that the individually named Petitioners, Maria Cruz Medina, Frances L. Aguilar, and Maria Martinez, lack standing to bring this action because the Administrative Record demonstrates that they never appeared during any of the proceedings before the adoption of the EIR. Petitioners contend that the individual Petitioners do have standing because the Center on Race, Poverty & Environment represented "residents in the Arvin/Lamont Area," among whom were the three named individual Petitioners. However, the Administrative Record lacks any indication that the three individually named Petitioners were being represented during the course of the public comment period in this matter, and counsel at oral argument conceded that a list of individuals submitted to the Board of Supervisors did not contain the names of those individuals. Therefore, the argument of Respondents concerning those individual Petitioners is valid, and
the Court finds they do not have standing to pursue remedies via this Petition.

Respondents further argue that there are certain issues raised by virtue of this Petition which were not set forth by any of the Petitioners bringing this action. Those matters include "the adequacy of the EIR's discussion of PM$_{10}$ impacts; the adequacy of the EIR's discussion of PM$_{2.5}$; mitigation measures for ammonia emissions; the issue of non-nitrogen salt loading; and expert comments regarding lagoon seepage." Petitioners cite to the record to demonstrate that the enumerated issues were in fact addressed in substance during the course of public comment on the project by themselves or others. The Court has reviewed the pertinent portions of the Administrative Record and has concluded that Respondents' objection based upon the ground that those issues were not addressed during the public comment period should be rejected.

Respondents also argue that, concerning the alleged inadequacy of the EIR's cumulative impact analysis, Petitioners had only asserted in the past that the EIR was flawed because of its lack of analysis of Kern County dairies, but now argue that the analysis should have addressed cumulative air impacts generated by all of the dairies in the eight counties which make up the San Joaquin Valley air basin. Furthermore, that the Petitioners never suggested there was a lack of discussion of a reasonable range of alternatives in the proposed EIR until the issue was raised in the Petition. As to these matters as well, the Court has reviewed the Administrative Record and concluded that there was sufficient
discussion during the course of the public comment period to justify the joinder of those issues in the present mandamus proceeding.

II.

DID THE EIR FAIL TO DESCRIBE AND ANALYZE THE CUMULATIVE IMPACTS FROM THE PROPOSED BORBA DAIRIES?

Petitioners allege that "The EIR's scope of cumulative impact analysis listed only Kern County dairies and failed to identify other sources in the region." They also complain that, to the extent that the EIR listed the 34 existing Kern County dairies and three additional recently approved dairies which have not yet been constructed, it made no effort to summarize "the expected environmental effects to be produced by these projects and a reasonable analysis of the cumulative impact" of them. Petitioners assert that rather than providing a comprehensive summary or analysis of the cumulative impacts of the existing and planned facilities, the report simply concludes there will be significant unavoidable impacts from cumulative air pollution from the dairies "but then makes excuses, saying no ready data is available on these kinds of facilities from government agencies, and therefore no assessment of the impact can be done."

Both Petitioners and Respondents rely on the language of CEQA Guidelines, Section 15130, and Respondent quotes as well from the discussion found in the Guidelines concerning section 15130, which clarifies that the cumulative impacts analysis "should include a discussion of projects under review by the Lead Agency and projects
under review by other relevant public agencies, using reasonable efforts to discover, disclose, and discuss the other related projects."

Respondents assert, however, that the paucity of available data made it difficult for the EIR to comprehensively analyze cumulative impacts with regard to the current project. They attempt to demonstrate that that is so by submitting the declaration of Kevin O’Dea, who was the project manager for the preparation of the EIR. An analysis of the efforts undertaken by Mr. O’Dea indicates that he attempted to get dairy information from the Kern County Planning Department and the Environmental Health Services Department; that he then contacted representatives of the Central Valley Regional Water Quality Control Board; and that he then contacted representatives of the California Department of Food and Agriculture Milk and Dairy Food Control Branch, all to no avail in his attempt to collect information which would allow him to do a comprehensive analysis of cumulative impacts. However, none of these sources proved helpful, for reasons set forth in his declaration.

In the meantime, however, it is apparent that much of the information for Kern County dairy herds was available to officials in the County (see AR 5057-5065). Furthermore, as was discussed during oral argument in this case, Respondents were unable to explain why they did not go to traditional sources of farm information such as the UC Extension Service Farm Advisor’s office in both Kern County and the other seven Counties in the southern
San Joaquin Valley to obtain the data necessary to make an appropriate analysis.

In *Whitman v. Board of Supervisors* (1979) 88 Cal.App.3d 397, 411, the Appellate Court said:

"We recognize that the 'sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible' and that perfection is not required (citing authority). On the other hand, the courts have favored specificity and use of detail in EIRs since "[a]" conclusory statement 'unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind' not only fails to crystallize issues (citation) but 'affords no basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives.'"

In the instant case the inadequacy of analysis of the cumulative impacts of the Borba Dairies and other existing and planned dairies in the basin rendered the EIR deficient insofar as cumulative impacts analyses were concerned.

III.

**DID THE EIR'S ANALYSIS OF ALTERNATIVES VIOLATE CEQA?**

Petitioners contend that the County violated CEQA because it did not analyze a reasonable range of alternatives to the project as proposed by the Borbas. Three alternatives were presented, being characterized as **No Project-No Build; No Project-Planned Build-Out;** and **Relocated Project Alternative.** The Board of Supervisors considered the alternatives and concluded: "For the reasons documented in the EIR and summarized below, the Board of Supervisors finds that adoption and implementation of the project
as approved is appropriate, and rejects each one and any combination of project alternatives as infeasible." There was no discussion regarding why other alternatives, such as a reduced size project, were not considered.

Petitioners assert that in the instant case, the range of alternatives really consisted of two possibilities: No Project, divided in two parts, and a relocated project which all agreed would not in any way mitigate or minimize the environmental impacts of the project.

Respondent argues that CEQA does not demand a minimum number of alternatives be presented. "The purposes of CEQA are not aided by creating more paperwork by formulating additional infeasible alternatives, for the sole reason of having a certain number of alternatives. CEQA requires only that a reasonable range of alternatives be considered. (CEQA Guidelines, Section 15126.6(a))."

In San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus (1994) 27 Cal.App.4th 713, 735, the Court of Appeal observed:

"A major function of an EIR 'is to ensure that all reasonable alternatives to proposed projects are thoroughly assessed by the responsible official.' (Citing authority) As explained by this court: 'An EIR must describe a range of reasonable alternatives to the project or to the location of the project, which could feasibly attain the basic objectives of the project and evaluate the comparative merits of the alternatives." (Citing authority) The discussion must focus on alternatives capable of eliminating any significant adverse environmental effects or reducing them to a level of insignificance,"
even if these alternatives would impede to some degree the attainment of the project objectives, or would be more costly." (Citing authority) This discussion of alternatives must be "meaningful" and must "contain analysis sufficient to allow informed decision making." (Citing Authority)"

While it is certainly true that nothing in the CEQA or its guidelines requires that a minimum number of alternatives to a project be discussed, it is also true that the discussion of alternatives must include a discussion of feasible alternatives. In the instant case, the Board of Supervisors did not deal with or discuss in any way alternatives other than the required No Project analysis and the Relocated Project Alternative, nor did it supply any reasons why consideration of other possible alternatives might have been discarded.

Petitioners urge the inadequacy of the treatment of alternatives herein because, inter alia, the EIR failed to discuss the possibility of a reduction in size of the project. Respondents point out that the EIR properly responded to comments suggesting a reduction in the size of the project and that the response was "... that a reduced herd size was considered in developing the alternatives for the EIR." While conceding that a reduced size could create environmental gains, Respondent argues that even so "PM_{10} and ROG emissions would remain significant and unavoidable even with a significant herd size reductions (sic)." Respondents appear to be arguing that, unless a reduction in herd size would eliminate negative environmental impacts, there was no need to consider the possibility of a reduced project. In fact, that is
not the law. The law requires that alternatives to the project which would mitigate or alleviate the impact on the environment must be explored so long as they are feasible. From the record before the Court in this matter, there is no demonstration that the feasibility of a reduced herd size model was explored in this case. "Feasible means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social and technological factors." (CEQA Guidelines, section 15364)

While the Board of Supervisors stated that it did consider a reduced herd size alternative, and discussed it in response to Comment 12-55, it then simply concluded that, although a reduction in herd size would result in a reduction in environmental impacts: "...the impact of PM_{10} and reactive organic gas emissions would remain significant and unavoidable in both of these cases (different herd size reductions) and neither alternative would meet the primary objectives of the applicants." Absent any evidence which demonstrates why a reduction of herd size would defeat the primary objectives of the applicants, there is no evidentiary authority for the conclusion drawn by the Board.

IV.

WAS THE ANALYSIS OF AIR QUALITY IMPACTS CONTAINED IN THE EIR INADEQUATE?

Petitioners argue the inadequacy of the air quality impacts discussion in the EIR because they contend that it contains no analysis "... of the health impacts that would result from
admittedly significant emissions of particulate matter (PM$_{10}$ and PM$_{2.5}$) due to dairy operations. Indeed, the document did not even estimate the quantity of fine particulate matter (PM$_{2.5}$) that would result from the huge amounts of ammonia emitted by livestock waste. "Respondents plead a dearth of available information to allow them to quantify PM$_{2.5}$ emissions, and, as to the failure to discuss the potential health impacts of PM$_{10}$ and PM$_{2.5}$, assert that "because the project is to be located at least one mile from any sensitive receptors, however, the record contains no evidence that PM$_{10}$ generated by the project could result in a significant health impact."

Review of the pertinent portions of the record demonstrates that, while standards have not been adopted by state and federal agencies regarding of the emissions discussed in this case, there is no evidence to indicate that there is an inability to quantify the amount of those emissions. Further, with the exception of a statement in the Administrative Record (2066) that: "...the SJVUAPCD has indicated that dairies located within one mile from a sensitive receptor could generate odors that may be significant," this Court has not been able to find any basis in the record for concluding that no health impacts are to be expected from the emissions under discussion if the nearest sensitive receptor (human habitation, schools, and the like) is located at least a mile away from the project. Finally, the Court would note the Administrative Record reflects (AR 2065) that there is at least one rural residence within .9 miles of the project.
Respondents argue they have done the best they can in conservatively treating issues involving the generation of PM$_{2.5}$ by declaring that those emissions would generate a significant impact. The fact that an impact is found to be significant and unavoidable, however, does not gainsay the fact that the EIR itself must detail to the extent possible the significance of the emission so that an informed public may comment upon that information.

V.

DID THE COUNTY VIOLATE CEQA BY FAILING TO ANALYZE AND ADOPT FEASIBLE MITIGATION MEASURES FOR AIR AND WATER QUALITY IMPACTS?

Petitioners allege that, while acknowledging the project will generate air pollution in the hundreds of tons of toxic gasses and particulates yearly, the County "... astonishingly found that there was no feasible mitigation for most of this air pollution. The Borbas themselves urged the adoption of a broad air pollution mitigation regime, albeit a vague one. The County ignored even the Borbas and forged blindly ahead in approving the project. The County's action must be remanded to address this critical emission ...."  

(A)

Petitioners specifically contend the County neither assessed nor adopted a number of feasible ROG control measures. The EIR originally required the use of an anaerobic digester. This was the only ROG mitigation measure evaluated in the EIR. However, the Borbas opposed the requirement of an anaerobic digester and suggested that they instead commit to using "the best available
economically feasible technology" in lieu thereof. But the Board rejected the anaerobic digester, and ultimately the mitigation measure adopted with regard to ROG was:

"The project shall provide for an aerobic treatment system or equivalent to stabilize the manure generated by the cattle prior to land application. The aerobic treatment system shall be designed to minimize the release of biogasses through conversion of gasses to electrical power or other methods."

Respondents argue that "under this mitigation measure, the Borbas must construct an aerobic treatment system or a system with equivalent results. The reference to 'conversion of gasses to electric power,' which would only be possible with an anaerobic system, makes clear that one way the Borbas may fulfill this mitigation measure is by constructing an anaerobic system. Therefore, petitioners' statement that the County required no mitigation for ROG is blatantly false."

The problem with the state of the record is that there is no adequate discussion within the EIR of available technology involving aerobic treatment. Even if ultimately found to be infeasible, evaluation of an aerobic system as a potential feasible mitigation should have been accomplished to determine whether it would substantially lessen the ROG impact before the mitigation measure was adopted in its final form. Furthermore, nothing in the EIR sets forth the standard to be used to determine that a substitute system would be equivalent to an aerobic treatment system.
Petitioners next attack the alleged failure of the EIR to assess and adopt feasible particulate matter mitigation measures. They allege that the sole mitigation measure proposed for particulate matter emissions during dairy operations was the application of a chemical stabilizer. Petitioners urge that the EIR should have considered offsets as a feasible mitigation measure for both particulate matter emissions and for ROG emissions.

Respondents reply that in addition to chemical stabilizer application, they also provided Mitigation Measure 4.2.3.3 which required the applicants to plant landscape trees along three sides of the dairy sites. Furthermore, there was a requirement for the regular removal and treatment of manure from the corrals to prevent it from becoming a PM$_{10}$ source.

There is ample evidence in the Administrative Record to justify the chemical treatment of particulate matter mitigation contained within the EIR. The suggestion by Petitioners that offsets be used to counter the effects of ROG emissions and particulate matter generation is effectively answered by Respondents' argument that to have a system of offsets there has to be an administering agency with the appropriate authority to supervise the program. Since the record demonstrates no such authority exists in that, for example, the SJVUAPCD does not regulate dairies as point sources, there is no basis in the record to suggest the feasibility of an offset system as a mitigation measure with regard to air quality control.
Petitioners next address the alleged failure to assess and adopt feasible mitigation measures for ammonia and hydrogen sulfide emissions. Petitioners argue that since ammonia and hydrogen sulfide will not be effectively regulated by the responsible air district and the EIR demonstrates their significance it must evaluate and/or require a mitigation measure for those emissions. Because the Court has already addressed issues concerning the adequacy or inadequacy of the assessment of the effects of the generation of air pollutants and the efficacy of the adoption of an aerobic or anaerobic treatment system, supra, there is no need for further discussion of this issue under this rubric.

Petitioners turn to a discussion of the alleged failure of the EIR to evaluate feasible mitigation measures for water quality impacts. They argue that the County failed to deal with the comments of the McAllister Ranch Irrigation District and the West Kern Water District regarding provision for the cost of remediation of ground water in the event it becomes polluted by the project operation. Respondents allege that the comments of the McAllister Irrigation Ranch District came late in the process and contend that the County did respond to the concern that the Sorbas be held responsible for potential effects on the ground water. However, the portion of the Administrative Record to which they cite (AR 8:4648-4649, 4853) do not deal with the issue presented. Since the recommended solution for the problem of mitigation in the event
groundwater was polluted by the dairies does not appear on the record before the Court to be facially infeasible, it must be addressed. (See Los Angeles Unified School District v. City of Los Angeles (1997) 56 Cal.App.4th, 1019, 1029.)

Petitioners raise two issues with regard to the question of potential seepage from the dairies' wastewater lagoons. First, they complain that the EIR includes no description or analysis of the soil underlying Dairy #2, and consequently there cannot be an informed evaluation of the water quality impact of that part of the project. Respondents contend that, since Dairy #2 is located adjacent to Dairy #1, the soil characteristics are expected to be nearly identical and therefore should not pose a problem. While this argument is not persuasive, Respondents make a second argument, which is that Mitigation Measure 4.3.3.2 contains performance standards for the hydraulic conductivity of the liner systems for both dairies. Given the state of the record, this Court cannot say that the decision of the Board to accept the mitigation measure and the planning in the EIR for the wastewater lagoon, insofar as Dairy site #2 was concerned, constituted an abuse of discretion, or was made without substantial evidence.

Petitioners second argument concerning the lagoons involves the alleged failure of the EIR to evaluate "... the volume of seepage, the quantity of pollutants and the speed at which they would reach groundwater...." They argue that the result constitutes a failure to include relevant information to allow
informed decision making by the Board, and also appropriate public participation in the project. In this regard they rely on the case of Kings County Farm Bureau v. City of Hanford (1990) 221 Cal.App.3d 692, 712. They also cite the case of Cadiz Land Company v. Rail Cycle (2000) 83 Cal.App.4th 74. The latter citation is appropriately attacked by Respondents who point out that the Petitioners' attempt to argue that the Cadiz case was a case concerning a failure to calculate volume of discharge from a project, when it really dealt with a failure to calculate the volume of a diminishing aquifer to ascertain whether or not the aquifer would disappear before expected pollution from the project reached the level of the groundwater.

Respondents go on to justify their treatment of the issue of leakage and their failure to provide a calculation of that leakage by further distinguishing the project in the Cadiz matter and the current project, pointing out that in Cadiz the EIR concluded groundwater contamination was highly unlikely and therefore not a significant impact, but that the current EIR and project approval "...recognizes that potential contamination is a significant impact and mitigation measures have been incorporated."

Respondents again appear to be of the view that if an EIR concludes a project threatens to create a significant impact upon the environment there is no further information to be provided with regard to that impact. But that is not the state of the law. Here calculation of the volume of seepage from the lagoons was crucial to the public's and the Board's ability to fairly analyze the
sufficiency of the proposed mitigation measures: "A prejudicial abuse of discretion occurs if the failure to include relevant information precludes informed decision-making and informed public participation, thereby thwarting the statutory goals of the EIR process." (Concerned Citizens of South Central LA v. Los Angeles Unified School Dist. (1994) 24 Cal.App.4th 826, 838.)

Consequently, the argument of Petitioners regarding the inadequacy of the analysis of the effects of leakage from the wastewater lagoons, although flawed by their distortion of the Cadiz holding, accurately characterizes the problem to be dealt with herein.

(F)

Concluding their attack on the alleged failure of the EIR to adequately deal with water quality impacts, Petitioners assert that the EIR does not sufficiently analyze the impacts of non-nitrogen salt loading. Little attention was paid to this issue in the presentation of evidence by Petitioner Sierra Club. Respondents argue that the RWQCB allows salt loading of up to 3,000 lbs/acre/year, whereas the project in question will load an estimated 401 lbs/acre/year. Consequently, it appears there was substantial evidence before the Board to justify the Board's

1 While Respondents contend the rate of seepage was reported in the EIR in centimeters per second, and that seepage from the lagoons can then be converted to volume of discharge by accomplishing "a simple conversion using information in the EIR," one purpose of the EIR is to make the public aware of significant environmental issues inherent in the development of a project. When one has to be familiar with mathematic formulas to understand significant information, the EIR does not accomplish one of its requisite goals.
approval of the project insofar as the issue of non-nitrogen salt loading was concerned.

CONCLUSION

Based upon the foregoing analysis, the parties to this action are entitled to relief as follows:

1. Individual Petitioners Maria Cruz Medina, Frances L. Aguilar, and Maria Martinez are dismissed from the action for want of standing.

2. The remaining Petitioners are entitled to a Writ of Mandate compelling Respondents/Real Parties to refrain from taking action in furtherance of the project until they comply with CEQA in the following regard:

   a. Performing a cumulative impact analysis which includes consideration of the effect of the 34 existing Kern County dairies, the three additional recently approved Kern County dairies, and the existing and approved (but not yet constructed) dairies in the remaining seven counties in the San Joaquin Valley Air Basin;

   b. Performing a meaningful analysis of feasible alternatives to the project in question, including the alternative of a reduction in the size of the project;

   c. Analyzing the health impacts that would result from the estimated emission of particulate matter due to dairy operations, and in the process estimating the quantity of fine particulate matter (PM₁₀) that would result from the operation of the project;
d. Analyzing the efficacy and practicality of the utilization of an aerobic treatment system (the mitigation measure adopted by the Board) and including a verifiable standard to be used to determine the basis for finding that a system to be put in place of an aerobic treatment system is an equivalent system;

a. Analyzing solutions for the cost of mitigation in the event groundwater is polluted by the project;

f. Detailing in a fashion comprehensible to members of the public and the Board the volume of leakage anticipated from the lagoons.
because of copyright concerns, but wanted to make sure you all had seen this.
Anne

-----Original Message-----
From: John Rebers [mailto:jrebers@nmu.edu]
Sent: Thursday, June 07, 2001 5:37 PM
To: Anne Woiwode
Subject: Drugs and bugs

They're cautious about the conclusions, but of interest for the CAFO stuff.

John Rebers


Gene tests lift lid on drug-resistance puzzle

JONATHAN KNIGHT

[ORLANDO] Is the use of antibiotics in farm animals causing the spread of antibiotic-resistance genes to human pathogens? The jury is still out, say experts who gathered last week at the annual meeting of the American Society for Microbiology in Orlando, Florida. But this long-standing controversy could soon be resolved, thanks to the development of molecular tools to help recognize resistance genes that originated on the farm.

Infections that resist treatment with antibiotics are a growing problem. Most researchers agree that over-prescription of antibiotics by doctors is the main cause.

But antibiotics are also routinely added to the feed of farm animals as minor infections can stunt their growth. This is promoting the emergence of antibiotic resistance among bacteria that inhabit or infect livestock. And such bacteria have been shown to cause some cases of human food poisoning.

http://10.1.1.29/mail/LIntern.nsf/3.../f7eefb280343b2488256a650055002f?OpenDocumen 06/08/2001
More worrying, however, is the possibility that farmyard antibiotic-resistance genes could be transferred to the bacteria that inhabit our bodies, creating an insidious reservoir of drug resistance. But it has proved difficult to demonstrate whether or not such gene transfer is occurring.

"It's hard to get agreement on the extent of the problem," says Walter Hill, an official with the US Department of Agriculture's Food Safety and Inspection Service.

Among those investigating the connection between farm antibiotics and human health is David Wagner, an animal scientist at the Food and Drug Administration's Center for Veterinary Medicine in Laurel, Maryland. He collected microorganisms from beef and poultry at local supermarkets, and found that two-thirds of one species of gut bacterium, Enterococcus faecium, sampled from chicken, were resistant to Synercid. This antibiotic has only been on the market for two years, and is used as a last resort to treat infections that resist the more commonly used vancomycin.

Although Synercid is not used in agriculture, its close cousin virginiamycin has been given to cattle, pigs and poultry for more than 20 years in the United States and Europe. Genes for virginiamycin resistance also confer resistance to Synercid, and the possibility that they can be transferred to human pathogens is a serious concern. "This is not good news," says Wagner of his findings.

Synercid treatment currently fails in only a tiny proportion of cases. But Stuart Levy of Tufts University in Boston, whose work on antibiotic resistance helped to open the field, advises caution. If resistance genes do transfer from livestock bacteria to those infecting humans, they could spread rapidly if Synercid becomes more widely used.
Other researchers are now using molecular techniques that can rapidly recognize specific mutations involved in antibiotic resistance. Roustat Aminov of the University of Illinois at Urbana-Champaign has developed tests, based on the polymerase chain reaction, that can identify eight different classes of gene that confer resistance to tetracycline. Bacteria from cows and pigs carry different characteristic combinations of resistance genes, and Aminov has used his tests to track the transfer of tetracycline-resistance genes from pig farms in Illinois to soil bacteria.

Mark Maiden, a geneticist at the Forsyth Institute in Boston, Massachusetts, has used similar tests and found matching tetracycline-resistance genes in human mouth bacteria and in bacteria from animal intestines. "You've got identical sequences turning up in quite different species," he says. "That's highly symptomatic of horizontal gene transfer."

Although oral bacteria cause nothing worse than dental cavities, Maiden says they could serve as a reservoir of tetracycline-resistance genes that might transfer to opportunistic bacteria that cause pneumonia or postoperative infections, making these more difficult to treat.

Maiden says he cannot prove that the genes did transfer from the animals' bacteria to the human oral bacteria — in theory, it could have been the other way around. But microbiologists are optimistic that the application of such molecular methods by more researchers will soon reveal the extent to which the transfer of farmyard resistance genes to human pathogens is occurring.

"We've needed this for many years," says Levy.
September 10, 2001

Board of Supervisors
Kings County Government Center
Hanford, CA 93230

Re: Proposed Revised Draft Dairy Element of the Kings County General Plan

Dear Board of Supervisors,

Thank you for the opportunity you have given the Kings County Farm Bureau to review and discuss the Revised Draft Dairy Element of the Kings County General Plan. We have spent many hours analyzing and reviewing the plan.

As you know, agriculture is very important to the economy of Kings County with revenues over $900,000 million dollars. The dairy industry remains at the top of the county's commodities for the fifth consecutive year with a value of over $300,000 million dollars. The dairy industry is directly and indirectly responsible for over 32,000 jobs in the county. Because of this fact, the Kings County Farm Bureau has undertaken this review responsibility very seriously. We have been very methodical in our review.

We appreciate the extension of time to review this document, however, the more we review, the more concerned we have become about the workability and practicality to implement the goals and policies put forth in the document. While the document seems to meet or exceed the California Environmental Quality Act requirements, it sets up policies that make it impossible to economically operate a dairy.

There are three major areas of concern:

1. Monitoring – The draft Dairy Element, as it stands, is regulatory oppressive with excessive and burdensome monitoring and compliance programs. It creates a paperwork nightmare with little or no environmental benefit. There is no reason to establish a Dairy Monitoring office. The expense of additional personnel and overhead associated with creation of a whole new bureaucracy is not needed. Certification should be the Quality Assurance Program should be considered as equivalent to any program established by Kings County.

2. Air Quality Policy – This entire policy promotes the development of bad public policy and should be reworked in accordance with the comments. By referencing incomplete research and mandate the implementation of otherwise voluntary programs, Kings County appears to agree with conjecture and opinion as opposed to scientific data. We at the Kings County Farm Bureau seriously question the science used to evaluate the significance the air quality impacts of dairies in the San Joaquin Valley.

3. Economic Impacts – While Dairy Element does consider the economic impact and job creation potential of the dairy industry, the numbers used are extremely conservative and grossly under-estimated. Also the social - economic impacts of implementation of the policies are not considered. In confering with various professionals in the area it is estimated that for the initial establishment of programs
(based on a 3,000-milk cow dairy) is approximately $290,000 or $96 per milking cow. The initial costs would be more per cow for smaller dairies trying to expand, as they would have fewer milk cows over which to spread the costs. Maintenance costs per year are approximately $230,000 per year or $76 per milking cow. These costs will increase over time. Since the monitoring requirements are applicable to all facilities, large or small, the figure may be multiplied by all cows to arrive at an annual cost. So, if there are 125,000 milk cows presently in Kings County then the cost to establish the program would be $12,000,000 and $3,500,000 to maintain the program. We have yet to quantify the environmental benefits, if any, derived from then initial and maintenance of the proposed programs.

At this time, as presented, because of all of the concerns set forth in the attachments, we at the Kings County Farm Bureau cannot support the adoption of the dairy element as proposed and would recommend a no vote when it is presented for adoption.

We at the Kings County Farm Bureau would like to offer our assistance in developing a document that meets the requirements of California Environmental Quality Act and a document the dairy industry cannot only live with but flourish under.

If the County of Kings and the Kings County Farm Bureau work together cooperatively toward the neutral and equally beneficial goals of clean water and air, we are confident a document based on peer reviewed science, recognizing and supporting the California Dairy Quality Assurance Program and associated third-party environmental evaluation, and United States Department of Agriculture's Agricultural Air Quality Task Force's voluntary compliance program, could be developed and implemented to achieve verifiable environmental protection and enhancement while exceeding the requirements of California Environmental Quality Act.

Again, thank you for the opportunity to comment on this very important document to the economic viability of Kings County. Please feel free to contact us with any questions or concerns.

Sincerely,

Chuck Draxler
Dairy Element Chairman

Comments attached

CD:rs/ss
## Section III - Policies for the Location and Siting of Dairies

<table>
<thead>
<tr>
<th>Pg.</th>
<th>Policy</th>
<th>Draft Dairy Element Regulation</th>
<th>KCFB Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-14</td>
<td>DE 1.2a &amp; 1.2b</td>
<td><em>Limited Agricultural (AL-10) zone districts.</em>&lt;br&gt;<em>Exclusive Agricultural (AX) zone districts.</em></td>
<td>The language could be more specific to state that only the new portion of an existing facility is subject to site plan review.</td>
</tr>
<tr>
<td>DE-14</td>
<td>DE 1.2c</td>
<td><em>Flood Zones.</em>&lt;br&gt;Dairy facilities, including corrals, barn, manure storage areas, feed storage areas, dairy lagoons, etc., shall not be located on any territory designated on the <em>National Flood Insurance Program, Flood Insurance Rate Maps (FIRM)(Community-Panel Numbers 060086 0001-0425) dated August 4, 1998</em>, as Special Flood Hazard Areas Inundated by 100-year Flood, Zones A, AE, AO, and AH, Floodway areas in Zone AE, of Other Flood Areas in Zone X.</td>
<td>These maps are subject to change and amendment. To tie all future development to a specific issue date is unreasonable and not beneficial to the County.</td>
</tr>
<tr>
<td>DE-15</td>
<td>DE 1.2d</td>
<td><em>High groundwater areas.</em></td>
<td>Construction and operation of new dairy facilities unless the applicant can demonstrate that the minimum vertical distance between proposed...</td>
</tr>
</tbody>
</table>
### Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-15</th>
<th>DE 1.2f</th>
<th><strong>Areas of excessive slope.</strong></th>
<th>Lagoon bottoms and highest anticipated groundwater level is at least five feet. This is the Title 27, Division 2, Subdivision 1, Chapter 15, '2562d, California Code of Regulations requirement.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Restriction on slopes over 5% is too severe. Proper grading design will allow drainage system to effectively contain runoff. No restriction on slope so long as facility is able to comply with requirements of California Regional Water Quality Control Board Title 27, Division 2, Subdivision 1, Chapter 15, '2560, California Code of Regulations.</td>
</tr>
<tr>
<td>DE-15</td>
<td>DE 1.2g</td>
<td><strong>Areas in the immediate vicinity of schools.</strong></td>
<td>As written an existing dairy with no option for expansion other than toward a school is effectively prohibited from growth, even if it pre-existed the school. Suggestion B encroachment be allowed through the Conditional Use Permit. For instance, expansion of the milking barn itself, of conversion of an open lot to a freestall system may well enhance the dairy as a neighbor to a school, even if it were located somewhat closer.</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element
of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-16</th>
<th>DE 1.2h</th>
<th>Separation of dairy facilities by 3 mile.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>This policy should allow more flexibility, and should recognize the dairy may have been in place before the school existed. Suggestion -- add if such expansion does not further encroach on the school site to the end of the first sentence of the second paragraph relating to existing dairies. Suggestion -- drop the prohibition of the final sentence beginning with: However, under no circumstances... etc., replace with a new sentence as follows: if an existing dairy is to expand its facility in a fashion that will further encroach on the non-conforming separation from the school a Conditional Use Permit will be required.</td>
</tr>
</tbody>
</table>

|       |        | Too restrictive to dairies that may have pre-existed their neighbor. Suggestion B drop However, under no circumstances and replacing it as follows: The existing separation shall be maintained to the maximum extent feasible. This will allow planning staff to be flexible to evaluate each situation on its merits and to accomplish compromise, while retaining the possibility of appeal. |
## Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-17</th>
<th>DE 1.2j</th>
<th><strong>Compatibility Zone Boundaries.</strong></th>
<th>Existing dairies need to be protected from restrictions on their ability to grow should &quot;compatibility zone&quot; boundary be extended in to conflict with them.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-18</td>
<td>DE 2.1</td>
<td>Streamline the permit process for establishing new dairies or expanding existing dairies. Site Plan Review (SPR)</td>
<td>Additional clarity that the Site Plan Review (SPR) applies only to the new portion of an existing facility is needed. Suggestion B New sentence as follows: <em>All new dairies and any new expansion of existing dairies with previously issued zoning permits shall be required to obtain a site plan review (SPR) of the new portion of the facility before construction or operation begins.</em></td>
</tr>
<tr>
<td></td>
<td>DE 2.1a</td>
<td>... maximum number of animal Units (AUs)...</td>
<td>The SPR review procedures will calculate the maximum number of animal units (AUs) based on Table 1 of Fact Sheet 4 for Dairies, California Regional Water Control Board, Central Valley Region, the proposed or expanding dairy site can potentially accommodate and establish the dairy's calculated capacity.</td>
</tr>
<tr>
<td>DE-18</td>
<td>DE 2.1b</td>
<td>Fluctuation in the herd size...</td>
<td>Substitute <em>up to</em> for <em>below</em> in the first sentence.</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-19</th>
<th>DE 2.1c &amp; 2.1d</th>
<th>DE 2.2</th>
<th>SPR for the expansion of dairies existing prior to 1979</th>
<th>DE-19</th>
<th>DE 2.2a</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial construction...</td>
<td>expansions...</td>
<td>1979</td>
<td>Date of adoption and dairy site capacity</td>
<td></td>
<td>Date of adoption and dairy site capacity</td>
</tr>
</tbody>
</table>

For additional clarity, both of these policies need to add the words on the new portion of the facility, to the end of the first sentence, after (SPR) and SPR consecutively.

For clarity – Suggestion – Any new expansion of dairies which were in existence prior to 1979 will require a Site Plan Review (SPR) on the new portion of the facility, except for dairies in the A-10 zone district, which will require a conditional use permit on the new portion of the facility.

Change July 1, 1998, to: adoption of this amendment to the Kings County General Plan.
### Review of the Revised Draft Dairy Element of the Kings County General Plan

**Section IV - Design Criteria for Individual Dairy Projects**

<table>
<thead>
<tr>
<th>Pg.</th>
<th>Goal</th>
<th><strong>Draft Dairy Element Regulation</strong></th>
<th><strong>KCFB Comments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-21</td>
<td>DE 3.1a</td>
<td>C. Air quality, including dust control, during construction and operations, odors, ROG, NOX, hydrogen sulfide, ammonia, and methane,</td>
<td>C. Air quality (during construction and operation), including dust control PM10, odors, ROG, NOX, hydrogen sulfide, ammonia, and methane, Dust is not regulated; PM10 is -- no sound science available for measurement of the air quality constituents named above.</td>
</tr>
<tr>
<td>DE-21</td>
<td>DE 3.1b</td>
<td>Residences that are not associated with the dairy. a 2 mile rule -- . . . as far as possible . . .</td>
<td>. . . as far as practical . . . . . . as far as possible is too severe and unattainable. Puts undue and impractical restraints on the existing dairies.</td>
</tr>
<tr>
<td>DE-22</td>
<td>DE 3.1c</td>
<td>. . . shall be located so that the separation shall not be reduced.</td>
<td>. . . shall be maintained in so far as feasible. Puts undue and impractical restraints on existing dairies. Precludes a pre-existing dairy from expanding in certain situations and directions. Could prevent existing dairies from expanding as needed to remain competitive within the industry and to provide the opportunity for younger</td>
</tr>
</tbody>
</table>

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6
### Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-22</th>
<th>DE 3.1d</th>
<th>Cultural Resources...</th>
<th>-- Omit Section -- Include in 3.1e</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-22</td>
<td>DE 3.1e</td>
<td>Archaeological, paleontological or cultural resources.</td>
<td>Consultation with local Native American groups should only be required in the event of discovery of Native American cultural artifacts, not for paleontological or other artifacts of antiquity. Suggestion -- add affecting Native American cultural resources at the end of the final sentence of this policy. DE 3.1e -- Simplify to be consistent with intent of 3.1d and 3.1e.</td>
</tr>
<tr>
<td>DE-23</td>
<td>DE 3.2a</td>
<td>The zoning administrator shall compare the suitability of a proposed new dairy or the expansion of an existing dairy to the various groundwater and surface water conditions in Kings County.</td>
<td>Change to: The Technical Report should address the following: A. Depth to first groundwater suitable for domestic and Ag use. B. Depth to first useable groundwater. C. Minimum separation from bottom of (lined and unlined) lagoons and corrals to ensure no contamination will occur to the ground water for</td>
</tr>
</tbody>
</table>

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000623

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23-24 Cont. 23-25
23-26
23-27
23-28
## Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-23</th>
<th>DE 3.2b</th>
<th><strong>The zoning administrator shall compare the various types of soils in Kings County to the crop requirements of the crops grown using the manure and process water from the dairy facility.</strong></th>
</tr>
</thead>
</table>
|       |         | **ag and domestic uses shall be a minimum of five (5) feet.**  
D. Proximity to watercourses: identify adjacent watercourses and improvements to protect the watercourse from discharges from the dairy.  
Simplification and consistency with existing regulations.** |
|       |         | **Change to: The Technical Report should address the following:**  
A. The soil type’s capacity at the dairy site to assimilate the various nutrients in the dairy process water and manure produced on dairies for crop production.  
B. The agronomic rates for crop production needs for the nutrients for the various crops that are grown on cropland irrigated with dairy process water and fertilized with solid manure generated by the dairy, with consideration for the soil types and depth of groundwater.  
Simplification and consistency with existing regulations.** |
| DE-23 | DE      | **Dairy process water shall not be discharged into**  
**Dairy process water shall not be discharged into** |
Review of the Revised Draft Dairy Element
of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-24</th>
<th>DE 3.2f</th>
<th>Design, implement and maintain a monitoring program.</th>
<th>any surface water, including rivers, creeks, intermittent streams, canals, reservoirs, lakes, ponds, sloughs, stormwater basins, floodplains, or floodways. To be consist with existing regulations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-24</td>
<td>DE 3.2g</td>
<td>Existing dairy facilities proposing to expand and are located in 100-year flood hazard area.</td>
<td>B. Provide 100-year flood protection for the dairy facilities by construction levees [beams] or other flood control structures. The applicant must acquire all necessary permits and regulatory approvals. C. -- Omit -- With proper grading and floodwater exclusion structures it is possible to construct a facility in the 100-year flood zone. The California Regional Water Quality Control Board requires a demonstration that the facility is protected from inundation in the event of a 100-year flood. Title 27, Division 2, Subdivision 1, Chapter 15, §2562, California Code of Regulations</td>
</tr>
</tbody>
</table>
### Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-24</th>
<th>3.2h</th>
<th>Hydrologic Sensitivity Assessment</th>
<th>-- Omit All --</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-25</td>
<td>DE 3.3a</td>
<td>Sensitive biological and wetlands</td>
<td>-- Omit: are located within a one-mile radius of an established refuge/preserve, or native areas. -- Omit: resources -- Omit: preferably Regulated by other agencies.</td>
</tr>
<tr>
<td>DE-26</td>
<td>DE 3.6a</td>
<td>Fire protection</td>
<td>-- Omit -- Covered under general building regulations. Also covered under 3.6b (repetitive)</td>
</tr>
<tr>
<td>DE-27</td>
<td>DE 3.6b</td>
<td>Fire protection</td>
<td>All applications for new and expanded dairy approvals shall be submitted to the Kings County Fire Department to ensure conformance of proposed dairy facilities with minimum fire protection standards for dairies.</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element of the Kings County General Plan

Dairy System Design Policy

<table>
<thead>
<tr>
<th>Pg.</th>
<th>Goal</th>
<th>Draft Dairy Element Regulation</th>
<th>KCFB Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-27</td>
<td>DE 4</td>
<td>Specific and Comprehensive system</td>
<td>Delete the word system as unnecessary or replace with system and techniques.</td>
</tr>
<tr>
<td>DE-27</td>
<td>DE 4.1</td>
<td>Comprehensive Nutrient Management Plan (CNMP)</td>
<td>Use the term Manure Nutrient Management Plan (MNMP) until such time as the Natural Resources Conservation has fully developed the parameters of their official Comprehensive Nutrient Management Plan (CNMP). A core working group has recently been formed by the NRCS and is meeting to create a uniform CNMP for use in California, but a true CNMP is yet to be defined. You may wish to reference this policy to the NRCS plan when it becomes available, A CNMP is expected to go beyond the issues of a MNMP in that it will consider such issues as erosion, crop residues and others. A MNMP is considered to a subset of a CNMP in the recent</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element
of the Kings County General Plan

draft of USEPA's CAFO rule, although they use the term Permit Nutrient Plan (PNP).

| DE-28 DE 4.1a | A. Feed Management
Evaluate the possibility of modifying diets and feed of the animals to reduce and feed of the animals to reduce the amounts of nutrients in manure | A. -- Omit -- Recent research indicates that it is not beneficial. |
| DE-28 DE 4.1a | Manure Handling and Storage | B.1. -- Omit -- Covered under the stormwater plan
B.2.b. The pits and lagoons shall be maintained so that the integrity of the liners are maintained leases due to infiltration and minimized.
B.2.c. The specific infiltration rate discharge of process water...
B.2.d. ... installation and inspection of the construction of the lagoons and of the liner system.
B.2.f. --Omit--
B.2.g. At the eerrale, naturally occurring or imported clayey soils shall underlie the eerrale
Review of the Revised Draft Dairy Element
of the Kings County General Plan

| DE-29 | DE 4.1a | Provide adequate storage. | and dry manure storage areas:
|       |        |                        | B.2.1. Specify domestic wells
|       |        |                        | change (150 feet) to (100 feet)
|       |        |                        | 3. Delete -- Dry manure shall be stored in
|       |        |                        | production buildings, storage facilities, or
|       |        |                        | otherwise covered to prevent precipitation from
|       |        |                        | coming into direct contact with the manure.
|       |        |                        | Liquid manure storage systems shall be designed
|       |        |                        | and constructed to store, handle, and transport
|       |        |                        | all of the quantity and contents of liquid manure
|       |        |                        | and dairy process water produced, runoff from
|       |        |                        | the dairy facility, and rainfall. Location of manure
|       |        |                        | storage systems shall consider proximity to water
|       |        |                        | bodies, floodplains, and other environmentally
|       |        |                        | sensitive areas.
|       |        |                        | 4. Manure Treatment Management -- manure
|       |        |                        | shall be managed, handled & treated to reduce
|       |        |                        | the loss of nutrients to the atmosphere during
|       |        |                        | storage...
Review of the Revised Draft Dairy Element of the Kings County General Plan
Review of the Revised Draft Dairy Element of the Kings County General Plan

**DAIRY SYSTEM DESIGN POLICY**

**SUMMARY OF COMMENTS:** This entire section promotes the development of bad public policy and should be reworked in accordance with the comments. By referencing incomplete research and mandate the implementation of otherwise voluntary programs. Kings County appears to agree with conjecture and opinion as opposed to scientific data.

<table>
<thead>
<tr>
<th>PAGE</th>
<th>POLICY</th>
<th>DESCRIPTION</th>
<th>KCFB COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-34</td>
<td>GOAL DE 5:</td>
<td>Promote protection of the San Joaquin Valley air quality through the reduction of adverse air emissions from dairies.</td>
<td>Promote protection of the San Joaquin Valley air quality through the reduction of adverse air emissions from dairies. Reason: The goal is to promote the improvement of air quality, from a human health perspective.</td>
</tr>
<tr>
<td></td>
<td>Objective DE 5.1</td>
<td>Implement air emissions control practices and technologies at dairies to reduce the potential for degradation of air quality and odor generation.</td>
<td>Implement air emissions control practices and technologies at dairies to reduce the potential for degradation of air quality and odor generation. Develop Voluntary Incentive Based Strategies at dairies that improve air quality. Reason: Scientific research combined with incentives whether in the form of financial</td>
</tr>
</tbody>
</table>
# Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-34</th>
<th>Policy DE 5.1a: The County shall participate in the efforts of the San Joaquin Valley Unified Air Pollution District (SJVUAPCD) in developing air emissions control guidelines for agricultural uses, including dairy operations.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The County shall participate in the follow efforts of the Agricultural Technical Advisory Committee for the San Joaquin Valley Unified Air Pollution District (SJVUAPCD) in developing air emissions control guidelines for agricultural uses, including dairy operations.</td>
</tr>
<tr>
<td></td>
<td>Reason: The Agricultural Technical Advisory Committee was established by the San Joaquin</td>
</tr>
</tbody>
</table>
### Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-34</th>
<th>Policy DE 5.1b: An <strong>'Odor Management Plan'</strong> (OMP) shall be required as part of the Technical Report submitted with each application to either establish a new dairy or expand an existing dairy. The Plan shall specifically address standard operating practices for livestock handling, and manure collection, treatment, storage, and land application. The plan shall also identify existing residences located near (at least within a 2-mile radius) the proposed new or expanded dairy. The plan shall...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Valley Unified Air Pollution Control District to develop the agricultural production component of the research program administered through the San Joaquin Valley Air Study Agency. A regional, scientific based approach to the air quality issue is necessary. The advisory committee and the air district, in conjunction with the participating agencies (USDA/NRCS) have developed a program recognizing the unique nature of agriculture. An <strong>'Odor Management Plan'</strong> (OMP) shall be required as part of the Technical Report submitted with each application to either establish a new dairy or expand an existing dairy. The Plan shall specifically address standard operating practices for livestock handling, and manure collection, treatment, storage, and land application. The plan shall also identify existing residences located near (at least within a 2-mile radius) the proposed new or expanded dairy. The plan shall...</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element 
of the Kings County General Plan

| also provide standard operating procedures/control measures to be implemented to protect these receptors from potential odors that could be generated from dairy operations. At a minimum, standard operating procedures shall include providing advance notification to nearby residences prior to the spreading of manure or dairy process water on cropland adjacent to the residences. |
|---|---|
| In addition, the standard operating practices in the OMP shall include provisions to facilitate the reduction or control of odors from dairy operations, and shall be consistent with the MTMP, required under Policy DE 5.1c of the Dairy Element. The MTMP shall also include quality assurance/quality control protocol to monitor the implementation and effectiveness of the OMP. The OMP shall be revised as necessary, based on the results of the monitoring program, to ensure that standard operating procedures are conducted in a manner that will reduce or control odor from dairy operations. |

23-48 Cont.
## Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-36</th>
<th>Policy DE 5.1d:</th>
<th>The owner/operator of a proposed dairy development or expansion shall also comply with the most recently adopted Regulation VIII rules (e.g., rules 8021 and 8081) established by the SJVUAPCD for construction activities, during facility pre-construction, construction, inactive construction period, and post construction, when applicable. In addition, the owner/operator of a proposed dairy development or expansion shall implement the following SJVUAPCD enhanced and additional control measures as deemed necessary by the</th>
<th>The owner/operator of a proposed dairy development or expansion shall also comply with the most recently adopted Regulation VIII rules (e.g., rules 8021 and 8081) established by the SJVUAPCD for construction activities, during facility pre-construction, construction, inactive construction period, and post construction, when applicable. In addition, the owner/operator of a proposed dairy development or expansion shall implement the following SJVUAPCD enhanced and additional control measures as deemed necessary by the</th>
</tr>
</thead>
<tbody>
<tr>
<td>000645</td>
<td></td>
<td>operations. Reason: As stated in DE 5.1a, this issue is best left to the recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District. A regional, scientific based approach to the air quality issue is necessary. The advisory committee and the air district, in conjunction with the participating agencies (USDA/NRCS) has developed a program recognizing the unique nature of agriculture.</td>
<td>operations. Reason: As stated in DE 5.1a, this issue is best left to the recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District. A regional, scientific based approach to the air quality issue is necessary. The advisory committee and the air district, in conjunction with the participating agencies (USDA/NRCS) has developed a program recognizing the unique nature of agriculture.</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>Kings County Planning Agency with consultation, if needed, from the SJVUAPCD:</th>
<th>by the Kings County Planning Agency, with consultation, if needed, from the SJVUAPCD:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Limit traffic speeds on unpaved roads to 15 miles per hour;</td>
<td>1. Limit traffic speeds on unpaved roads to 15 miles per hour;</td>
</tr>
<tr>
<td>2. Install sandbags or other erosion control measures to prevent silt runoff to public roadways from sites with a slope greater than one percent;</td>
<td>2. Install sandbags or other erosion control measures to prevent silt runoff to public roadways from sites with a slope greater than one percent;</td>
</tr>
<tr>
<td>3. Install temporary wind breaks at windward side(s) of the construction areas;</td>
<td>3. Install wheel washers for all exiting trucks, or wash off all trucks and equipment leaving the site;</td>
</tr>
<tr>
<td>4. Suspend excavation and grading activity when winds exceed 20 miles per hour; and</td>
<td>4. Install temporary wind breaks at windward side(s) of the construction areas;</td>
</tr>
<tr>
<td>5. Limit the area of land subject to excavation, grading, and other construction activity at any one time.</td>
<td>5. Suspend excavation and grading activity when winds exceed 20 miles per hour; and Limit the area of land subject to excavation, grading, and other construction activity at any one time.</td>
</tr>
</tbody>
</table>

Reason: All that is necessary is to reference the control strategies identified in the regulating agencies requirements, i.e. the San Joaquin Valley Unified Air Pollution Control District.
# Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-36</th>
<th>Policy DE 5.1e:</th>
<th>Restatement of the requirements is redundant and unnecessary.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To ensure that potential fugitive dust emissions from cattle movement and maintenance activities at the unpaved corrals, perimeter roadways, and other unpaved areas throughout dairy sites are reduced, unpaved areas shall be effectively stabilized by use of water (expected efficiency of 50 percent) or chemical stabilizer/suppressant (expected efficiency of 75 percent) that is safe for the environment and cattle. Stabilization shall be conducted in a manner that will not result in the potential for breeding of mosquitoes and other vectors. The owner/operator shall also ensure that manure generated in the corrals is removed frequently to prevent the manure from becoming a PM$_{10}$ source; and removal activities shall be conducted in a manner that will minimize dust emissions.</td>
<td>To ensure that potential fugitive dust emissions from cattle movement and maintenance activities at the unpaved corrals, perimeter roadways, and other unpaved areas throughout dairy sites are reduced, unpaved areas shall be effectively stabilized by use of water (expected efficiency of 50 percent) or chemical stabilizer/suppressant (expected efficiency of 75 percent) that is safe for the environment and cattle. Stabilization shall be conducted in a manner that will not result in the potential for breeding of mosquitoes and other vectors. The owner/operator shall also ensure that manure generated in the corrals is removed frequently to prevent the manure from becoming a PM$_{10}$ source; and removal activities shall be conducted in a manner that will minimize dust emissions.</td>
</tr>
</tbody>
</table>

Reason: This requirement regulates dust, which is
### Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-37</th>
<th>Policy DE 5.1f:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A &quot;Livestock Management Plan&quot; (LMP) shall be required as part of the Technical Report submitted with each application to either establish a new dairy or expand an existing dairy. The &quot;Livestock Management Plan&quot; will identify practices to reduce methane emissions from ruminant livestock; and shall be consistent with the voluntary practices incorporated in EPA's Ruminant Livestock Efficiency Program.</td>
</tr>
</tbody>
</table>

|       | A "Livestock Management Plan" (LMP) shall be required as part of the Technical Report submitted with each application to either establish a new dairy or expand an existing dairy. The "Livestock Management Plan" will identify practices to reduce methane emissions from ruminant livestock; and shall be consistent with the voluntary practices incorporated in EPA's Ruminant Livestock Efficiency Program. |

Reason: this is another of numerous plan development requirements addressing a non-

Further, the requirement regulates all farm roads. This is unacceptable public policy and in fact institutes a Permit to Farm requirement; the requirement should be deleted.

Again, the County is requested follow the recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District and the USDA Agricultural Air Quality Task Force.
Review of the Revised Draft Dairy Element
of the Kings County General Plan

| DE-37 | Policy DE 5.1g: | The owner/operator of a proposed dairy development or expansion shall ensure that the following measures are implemented to control emissions (ROG, NOx, and PM$_{10}$) generated from heavy-duty construction equipment:
1. The idling time of all construction equipment used at the site shall not exceed ten minutes;
2. Minimize the hours of operation of heavy duty equipment and/or the number of equipment in use at one time;
3. All equipment shall be properly tuned and maintained in accordance with the manufacturer's specifications;
4. When feasible, alternative fueled or electrical

| | | The owner/operator of a proposed dairy development or expansion shall ensure that the following measures are implemented to control emissions (ROG, NOx, and PM$_{10}$) generated from heavy-duty construction equipment:
1. The idling time of all construction equipment used at the site shall not exceed ten minutes;
2. Minimize the hours of operation of heavy duty equipment and/or the number of equipment in use at one time;
3. All equipment shall be properly tuned and maintained in accordance with the manufacturer's specifications;
4. When feasible, alternative fueled or electrical |
Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-38 Policy DE 5.1h:</th>
<th>All applications for proposed dairies and all dairy expansions requiring a SPR shall include a...</th>
</tr>
</thead>
<tbody>
<tr>
<td>000650</td>
<td>construction equipment shall be used at the project site; 5. Use the minimum practical engine size for construction equipment; Gasoline-powered equipment shall be equipped with catalytic converters, where feasible; 7. Curtail construction during periods of high ambient pollutant concentrations; this may include ceasing of construction activity during the peak-hour of vehicular traffic on adjacent roadways; 8. Implement activity management (e.g., rescheduling activities to reduce short-term impacts).</td>
</tr>
<tr>
<td>23-52 CONT.</td>
<td>construction equipment shall be used at the project site; 6. Use the minimum practical engine size for construction equipment; Gasoline-powered equipment shall be equipped with catalytic converters, where feasible; 7. Curtail construction during periods of high ambient pollutant concentrations; this may include ceasing of construction activity during the peak-hour of vehicular traffic on adjacent roadways; Implement activity management (e.g., rescheduling activities to reduce short-term impacts).</td>
</tr>
</tbody>
</table>

Reason: As stated previously all that is necessary to reference the control strategies identified in the regulating agencies' requirements, i.e., the San Joaquin Valley Unified Air Pollution Control District. Restatement of the requirements is redundant and unnecessary.
Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>DE-38</th>
<th>Policy DE 5.1i:</th>
<th>All dairies shall comply with the Best Available Control Measures (BACM) for fugitive dust emissions from agricultural sources as</th>
</tr>
</thead>
<tbody>
<tr>
<td>00654</td>
<td>Fugitive Dust Emissions Control Plan as part of the Technical Report which describes and demonstrates conformance with Policy DE 5.1e and SJVUAPCD requirements for the control of fugitive dust emissions.</td>
<td>Dust Emissions Control Plan as part of the Technical Report which describes and demonstrates conformance with Policy DE 5.1e and SJVUAPCD requirements for the control of fugitive dust emissions.</td>
</tr>
<tr>
<td></td>
<td>Reason: This requirement regulates dust, which is not a regulated criteria pollutant under the federal Clean Air Act or the California Clean Air Act. This is unacceptable public policy and in fact institutes a Permit to Farm requirement; the requirement should be deleted.</td>
<td>Again, the County is requested follow the recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District and the USDA Agricultural Air Quality Task Force.</td>
</tr>
</tbody>
</table>

All dairies shall comply with the Best Available Control Measures (BACM) for fugitive dust emissions from agricultural sources as recommended by the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District and the USDA Agricultural Air Quality Task Force.
Review of the Revised Draft Dairy Element of the Kings County General Plan

<table>
<thead>
<tr>
<th>established by the most recently adopted SJVUAPCD Regulation VIII. The Fugitive Dust Emissions Control Plan, as required by Policy DE 5.1h, shall specify the BACMs that will be implemented during dairy operation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason: This requirement regulates dust, which is not a regulated criteria pollutant under the federal Clean Air Act or the California Clean Air Act. This is unacceptable public policy and in fact institutes a Permit to Farm requirement; the requirement should be deleted.</td>
</tr>
<tr>
<td>Again, the County is requested follow the recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District and the USDA Agricultural Air Quality Task Force.</td>
</tr>
<tr>
<td>DE-38</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

As part of the Technical Report to be submitted with each application to either establish a new dairy or expand an existing dairy, dairy applicants shall be required to estimate the anticipated net increase in ROG, NOx, and PM<sub>10</sub> emissions generated from anticipated dairy equipment (including cropland and dairy farm equipment) compared to existing conditions and demonstrate that the net increase will not exceed the SJVUAPCD threshold limits for ROG, NOx, and PM<sub>10</sub>.

Reason: Farm Crop production activities are not to be considered in addressing dairy development. This exceeds the scope of this element. This is unacceptable public policy and in fact institutes a Permit to Farm requirement; the requirement should be deleted. The threshold limitations referenced may in fact prohibit the future expansion and/or development of new dairies. It appears that not much thought went into the ramifications, necessity, or public policy implications of such a shortsighted requirement.

Again, the County is requested follow the...
| DE-38 | Policy DE 5.1k: Prior to conversion of dairy facilities to other land uses, the operator/owner of the facility shall submit documentation to the Kings County Dairy Monitoring Office that demonstrates that all residual manure and process water has been removed and managed in accordance with the facility's CPWDP and MTMP | recommendations of the Agricultural Technical Advisory Committee of the San Joaquin Valley Unified Air Pollution Control District and the USDA Agricultural Air Quality Task Force. Prior to conversion of dairy facilities to other land uses, the operator/owner of the facility shall submit documentation to the Kings County Dairy Monitoring Office that demonstrates that all residual manure and process water has been removed and managed in a proper manner, in accordance with the facility's CPWDP and MTMP. | Reason: The County seems to request the development of a closure plan. Identify this as such without reference to the previous plans, which have been recommended for deletion. Closure plan requirements may be developed separately outside any other operational permitting requirements. For all of Goal 5 and Policies 5.1a through 5.1k, the implementation of the Voluntary Incentive Based Reduction Plan would be better suited to |
Review of the Revised Draft Dairy Element
of the Kings County General Plan

achieve this goal (attached)

Also Implementation Dairy Best Available Control Technologies (DBACT) and Dairy Reasonable Available Control Technologies

23-56
Cont.
### Review of the Revised Draft Dairy Element of the Kings County General Plan

#### V. DAIRY Monitoring Program

The draft Dairy Element, as it stands, is regulatory oppressive with excessive and burdensome monitoring and compliance programs. It creates a paperwork nightmare with little or no environmental benefit. Certification should be the Quality Assurance Program should be considered as equivalent to any program established by Kings County.

<table>
<thead>
<tr>
<th>PAGE</th>
<th>POLICY</th>
<th>DESCRIPTION</th>
<th>KCFB COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-39</td>
<td>GOAL DE 6:</td>
<td>Implement a monitoring program that both demonstrates the Dairy Element's effectiveness in protecting the environment, and the effectiveness of those mitigation measures for each operation dairy facility in Kings County.</td>
<td>--Omit --</td>
</tr>
<tr>
<td>059000</td>
<td></td>
<td></td>
<td>Replace with the Quality Assurance Program and develop an annual reporting protocol that is less oppressive and that accomplishes the same goal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>There is no sound, peer reviewed science to determine and measure elements in Policy 6.1d, e, and f.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.1g -- overly intrusive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.1h -- Overseen by other agencies.</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element of the Kings County General Plan

VI. DAIRY Conformance Program – Certification should be the Quality Assurance Program should be considered as equivalent to any program established by Kings County.

<table>
<thead>
<tr>
<th>PAGE</th>
<th>POLICY</th>
<th>DESCRIPTION</th>
<th>KCFB COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE-46</td>
<td>GOAL DE 8:</td>
<td>Bring all existing non-permit holding dairies in Kings County into voluntary conformance with specific policies for existing dairies by the end of 2006.</td>
<td>Certification should be the Quality Assurance Program should be considered as equivalent to any program established by Kings County. The Quality Assurance Program will accomplish all of the objectives in VI. The time limit is too soon to bring all dairies in to compliance. The animal baseline should be established at the time of adoption of the element. If it is to be voluntary then why the drop dead date of 2008?</td>
</tr>
</tbody>
</table>
Review of the Revised Draft Dairy Element of the Kings County General Plan

Animal Unit Calculation tables to be included in Section II.

As per California Regional Water Quality Control Board, Central Valley Region, Fact Sheet 4: Animal units shall be calculated (based on a common denominator of one animal unit equals a 1,000 pound animal) as follows:

<table>
<thead>
<tr>
<th>Animal</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cows</td>
<td>1.00</td>
</tr>
<tr>
<td>Dry Cows</td>
<td>0.80</td>
</tr>
<tr>
<td>Heifers (2 years and older)</td>
<td>0.73</td>
</tr>
<tr>
<td>Heifers (1 year to breeding)</td>
<td>0.73</td>
</tr>
<tr>
<td>Calves (3 months to 1 year)</td>
<td>0.35</td>
</tr>
<tr>
<td>Baby Calves (&lt;3 months)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Adjustments for Animal Breed: The AU values above are based on 1,000 pound AU per Title 40 code of Federal Regulations, Section 122, and can be used directly for Jersey cows, for Guernsey's, multiply the Milk Cow and AU values by 1.2 before using them in Table 2; for Holsteins, multiply the Milk Cow and AU values by 1.4 before using them in Table 2.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Jersey Cows</th>
<th>Guernsey's</th>
<th>Holsteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cows</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
</tr>
<tr>
<td>Dry Cows</td>
<td>0.80</td>
<td>0.96</td>
<td>1.12</td>
</tr>
<tr>
<td>Heifers (2 years and older)</td>
<td>0.73</td>
<td>0.88</td>
<td>1.02</td>
</tr>
<tr>
<td>Heifers (1 year to breeding)</td>
<td>0.73</td>
<td>0.88</td>
<td>1.02</td>
</tr>
<tr>
<td>Calves (3 months to 1 year)</td>
<td>0.35</td>
<td>0.42</td>
<td>0.49</td>
</tr>
<tr>
<td>Baby Calves (&lt;3 months)</td>
<td>0.21</td>
<td>0.25</td>
<td>0.29</td>
</tr>
</tbody>
</table>
APPENDIX B

DEFINITIONS OF TERMS USED IN THE DAIRY ELEMENT

1. AFO (or CAFOs) not consistent with the Federal definition and Federal re-evaluating these definitions.

2. ANIMAL UNITS (AU) Source: RWQCB: Fact Sheet 4. See attached from RWQCB.

3. BASELINE CAPACITY OF A DAIRY:

8. DBACT - DAIRY BEST AVAILABLE CONTROL MEASURES - Dairy practices and/or technology which meet all the following: (a) are economically and technologically feasible, and (b) have been successfully implemented in commercial operations, and (c) which have been proven through scientific, peer reviewed research, to achieve the greatest control of pollutants.

9. DBACT - DAIRY BEST AVAILABLE RETROFIT CONTROL TECHNOLOGY - Dairy practices and/or technology which meet all the following: (a) are economically and technologically feasible, and (b) have been successfully implemented in commercial operations, and (c) which have been proven through scientific, peer reviewed research, to control pollutants.
DAIRY WASTE MANAGEMENT:
AN INTEGRATED APPROACH TO
EDUCATION AND COMPLIANCE

A partnership agreement between:

the State of California,
various Federal Agencies,
the University of California,
and the
California Dairy Industry

Signing completed
at a ceremony held at

The University of California, Davis campus

September 9, 1999
The California Dairy Quality Assurance Program
(Environmental Stewardship component)

Partnership Agreement Summary

This "Partnership Agreement" is to formalize a cooperative agreement between the California Dairy Quality Assurance Program (CDQAP), the University of California Cooperative Extension (UCCE), the California Department of Food and Agriculture (CDFA), the California Environmental Protection Agency and the State Water Resources Control Board (Cal-EPA-SWRCB), the California Resources Agency and Department of Fish and Game (CRA-DFG), and three organizations within the United States Department of Agriculture: Animal Plant Health Inspection Service (APHIS), the Natural Resources Conservation Service (NRCS), the Farm Services Agency (FSA), and Region 9 of the United States Environmental Protection Agency (US-EPA).

The purpose of this Partnership Agreement is to support the Environmental Stewardship component of the CDQAP as a voluntary, cooperative government and industry education/facility evaluation program. The program's objective is to assist California dairy producers in meeting all federal, state, regional and local requirements relating to manure and nutrient management. The program's ultimate goal is to help ensure a healthful environment for the people and wildlife of the state of California. The program core components include continuing education workshops for producers, the creation of Environmental Stewardship Farm Management Plans tailored to each dairy, and on-site evaluation by a third party.

Each of the participating State and Federal agencies will support the partnership to the extent that it does not conflict with any agency's statutory and regulatory obligations. The parties to the Partnership Agreement recognize their related interests and by mutual agreement will create a framework to enhance public and environmental health in the State of California. Industry organizations supporting this agreement include: California Dairy Research Foundation, California Farm Bureau Federation, California Manufacturing Milk Advisory Board, California Milk Advisory Board, Milk Producers Council, and Western United Dairymen. Technical support including education and training is being provided by the University of California, Davis.

000661
Environmental Stewardship
Partnership Agreement Signatories

William H. Hickox
Winston Hickox Secretary
California Environmental Protection Agency

Mary Nichols
Mary Nichols, Secretary
The California Resources Agency

Walt Pettit
Walt Pettit, Executive Director
State Water Resources Control Board

Jeff Vore
Jeff Vore, State Conservationist
USDA Animal and Plant Health Inspection Service

Paul O. Ugstad
Paul O. Ugstad, Area-Div. In-Charge
USDA Animal and Plant Health Inspection Service

Frank C. Dias
Frank C. Dias, Chairman
California Manufacturing Milk Advisory Board

Ray Souza
Ray Souza, President
Western United Dairymen

William (Bill) J. Lyons Jr.
William (Bill) J. Lyons Jr., Secretary
California Department of Food and Agriculture

Felicia Marcus
Felicia Marcus, Regional Administrator,
US Environmental Protection Agency Region 9

Robert C. Hight
Robert C. Hight, Director
California Department of Fish and Game

Val Dolseth
Val Dolseth, State Executive Director
USDA Farm Service Agency

W. R. Gomes
W. R. Gomes, V.P. Ag. and Natural Resources
University of California

Bill Paulli
Bill Paulli, President
California Farm Bureau Federation

Bob Feenstra
Bob Feenstra, Executive Director
Milk Producers Council

Charles Ahlem, Chairman
California Dairy Quality Assurance Program

000662
PARTNERSHIP AGREEMENT
between the
CALIFORNIA DAIRY INDUSTRY ORGANIZATIONS
which are members of the
CALIFORNIA DAIRY QUALITY ASSURANCE PROGRAM
(Environmental Stewardship Component)
and
FEDERAL AND STATE AGENCIES

I. Agreement to Establish Partnership

This "Partnership Agreement" (PA) is to formalize a cooperative agreement between the California Dairy Quality Assurance Program (CDQAP), the University of California Cooperative Extension (UCCE), the California Department of Food and Agriculture (CDFA), the California Environmental Protection Agency and the State Water Resources Control Board (Cal-EPA-SWRB), the California Resources Agency and Department of Fish and Game (CRA-DFG), and three agencies within the United States Department of Agriculture: Animal Plant Health Inspection Service (APHIS), the Natural Resources Conservation Service (NRCS), the Farm Services Agency (FSA); and Region 9 of the United States Environmental Protection Agency (US-EPA).

The term "Partnership," as used in this agreement, is not intended to create a partnership within the meaning of California Corporations Code section 15006, that is, an association of two or more persons to carry on as co-owners a business for profit. No party to this agreement is authorized to enter into any contract or arrangement on behalf of any other party to this agreement in the absence of specific written authorization. Furthermore, it is intended that each party to this agreement shall bear its own liability for its own acts and shall assume no liability for the acts of any other party to this agreement. Industry organizations supporting this agreement include the California Dairy Research Foundation, California Farm Bureau Federation, California Manufacturing Milk Advisory Board, Milk Producers Council, and Western United Dairymen.

The Partnership Agreement will ultimately result in a voluntary, cooperative government and industry environmental stewardship education program. Producers completing this education program will become "certified." The term "certified" or "certification" as used in this agreement, carries no regulatory significance other than to inform local, regional, state and federal agencies of the producer's efforts in meeting compliance. Nothing in this agreement shall be construed as surrendering existing statutory or regulatory authority of any regulatory agency. Nothing in this agreement shall be construed to release a dairy operator from complying with the applicable federal, state, regional or local environmental statutes, regulations, permits, or orders.
The exact policies and procedures by which a producer will become certified will be determined following a pilot program to be coordinated by the California Department of Food and Agriculture (see Section VIII). Other interested parties such as the California Regional Water Boards and the Department of Health Services will be invited to participate in both the pilot program and the development of certification policies and procedures. The policies and procedures will be agreed to by unanimous consent of all partners prior to their implementation.

II. Partnership Purpose and Goals

The purpose of this Partnership Agreement is to support the California Dairy Quality Assurance Program as a voluntary, cooperative government and industry education and facility evaluation program. The program’s objective is to assist California dairy producers in meeting all federal, state, regional and local regulations relating to manure and nutrient management. The program’s ultimate goal is to help ensure a healthful environment for the people and wildlife of the state of California. The program core components include continuing education workshops for producers, the creation of Environmental Stewardship Farm Management Plans specific to each dairy, and on-site evaluation by a third party. However, third party evaluation and certification is not a determination that a facility is in compliance with environmental laws and regulations.

In order to facilitate the education and certification of the state’s dairy producers, all partners in this agreement will cooperate in the development of training materials designed to assist dairy producers into coming into compliance with all federal, state, regional and local environmental rules and regulations. Each of the participating state and federal agencies and industry organizations will support the partnership to the extent that it does not conflict with any agency’s statutory and regulatory obligations. The parties to the Partnership Agreement recognize their related interests and by mutual agreement will create a framework to enhance public and environmental health in the State of California.

III. Program Areas and Activities

This agreement sets forth the working arrangements among these agencies and participating industry organizations concerning mutual planning, sharing of information, and training in matters relating to environmental stewardship for dairy producers. Principal considerations will be the enhancement of environmental health through education and sharing of information.

Each of the signatories will support the agreement in the following areas:

a. The primary responsibility of all partners are: 1) to develop training materials designed to assist producers in determining their compliance with all federal, state, regional and local environmental laws and regulations related to dairy manure and nutrient management 2) to communicate and coordinate with each other to assist producers in achieving compliance. A product of this effort will be an environmental compliance check-list and related educational materials for use by dairy producers and their advisors in developing and implementing Environmental Stewardship Farm Management Plans.
b. Each partnering organization will have a primary contact/coordinator and a backup. Contact information (office / mobile / pager / FAX / electronic mail phone numbers) will be made available to all partners.

c. Planning meetings will be scheduled yearly (or at more frequent intervals if deemed necessary by all parties). Meetings will be scheduled at least 30 days in advance. The purpose of the meetings will be to: (1) share information on related activities within each organization (2) evaluate the effectiveness of the agreement and (3) make recommendations for improving the agreement.

d. Meetings may be requested by any partner to address issues related to the program.

IV. The California Dairy Quality Assurance Program

The California Dairy Quality Assurance Program (CDQAP) will coordinate efforts of the dairy industry, government, and academic partners participating in this agreement. This program is a voluntary state, federal and industry cooperative whose mission is to "... encourage science-based dairying practices which promote the health of the consumer, the environment, and dairy livestock." Technical assistance for the program is being provided by the University of California, Davis. The program is currently funded by grants from the California Manufacturing Milk Advisory Board. While the food safety and animal health modules of the program are currently under development, environmental stewardship represents the first element of the program to be implemented. Obligations of the public and private signatories of this agreement are limited to the elements of the agreement itself. Participation in this agreement in no way obligates collaborating organizations or individual producers to participate in any other components of the CDQAP (such as the food safety and animal health/welfare modules).

Dairy producers in California may voluntarily choose to become certified by the CDQAP in environmental stewardship. The requirements and benefits of this certification as well as the role each of the organizations participating in this Partnership Agreement will play in the certification process are outlined below. The process by which a producer is certified will be finalized by unanimous consent of all partners following completion of the certification pilot project (see Section I).

V. Requirements for Producer Certification

Participation in the program by a dairy producer is strictly voluntary. These certification requirements are intended to assist the producer in complying with laws and regulations set forth in 1) the California Porter Cologne Water Quality Control Act, 2) the federal Safe Drinking Water Act, 3) the federal Clean Water Act, 4) the California Fish and Game Code and the 5) federal Coastal Zone Management Act. In order for a producer to become certified in the Environmental Stewardship program, each of the three requirements listed below must be completed.
By participating in this partnership agreement, the signatories to this agreement are not making a
determination that producers receiving third party certification are in compliance with applicable
laws. However, third party certification is one mechanism by which local, state, and federal
regulatory agencies are informed of a producer’s efforts in achieving compliance with
environmental laws.

1. Environmental Stewardship Short Course - Each producer (or authorized employee
representing the dairy) must complete a workshop in environmental stewardship developed or
approved by University of California Cooperative Extension (UCCE). Workshops will be held at
various locations throughout the state and conducted by UCCE trained staff. Certificates of
completion will be provided and records of attendance kept by UCCE.

2. Environmental Stewardship Farm Management Plan and associated documents - Each producer
(or authorized employee representing the dairy) will complete an Environmental Stewardship
Farm Management Plan and other associated documents tailored to his or her dairy. The producer
is responsible for developing the farm management plans and the plans shall remain at the facility.
A regulatory agency’s authority to gather information, an operator’s right to withhold information
and the public’s right to access the information shall be governed by existing laws and regulations.

These plans will include (but are not necessarily limited to):

A. Completed risk assessment documents.
B. Calculations describing current wastewater storage capacity and calculations of
storage capacity necessary to prevent discharge from the dairy in the event of a 25-
year, 24-hour storm.
C. Calculations demonstrating that existing wastewater capacity is capable of storing
contaminated runoff from a 25-year, 24-hour storm and maintain at least two feet of
freeboard.
D. A map of the dairy facility and crop land indicating where inappropriate surface
discharge and/or groundwater infiltration could occur (a stormwater pollution
prevention plan).
E. A narrative describing how surface and groundwater discharges will be prevented. The
map and narrative will address: 1) containment of all facility waste water up to and
including contaminated rainwater from a 25-year, 24-hour storm event, 2) prevention
of washout of storage ponds from a 20-year flood (or 100-year flood for dairies built
after November 27, 1984), 3) exclusion of cattle (that are fully or partially on feed and
located on anything other than pasture) from entering surface waters (ponds, creeks,
etc.), 4) diversion of uncontaminated precipitation and surface drainage from manure
or wastewater storage areas, and 5) operation and maintenance practices related to
storm water management.
F. An emergency plan which describes how appropriate resources will be mobilized in the
event of a discharge or impending discharge.
G. Documentation that the operator has fulfilled the local, state and federal environmental
regulatory requirements.
H. Documentation that the operator meets applicable requirements for dairy storage ponds and land application of manure and wastewater.

I. Other such elements as may be required by the local or regional water quality control board, for example Waste Discharge requirements.

3. Initial On-site Evaluation - The producer (or authorized employee representing the dairy) will participate in an on-site evaluation by a third party. This evaluation will only occur at the request of the producer. A check-list cooperatively developed by the participants in this Partnership Agreement will be used as the evaluation tool. Evaluations will rely heavily on examination of the Environmental Stewardship Farm Management Plan and related documents developed by the producer. The evaluation will include a visual assessment of the waste containment and runoff control facilities. The on-site evaluation will be non-regulatory in nature. Following successful completion of an evaluation, the third party will notify UCCE which will complete the certification process.

In the event that the on-site evaluation reveals circumstances which need to be corrected, the evaluator will leave an itemized list of corrections and will schedule a subsequent re-evaluation. Upon successful completion of the re-evaluation, the third party will notify UCCE, which will complete the certification process.

If a producer owns more than one facility, an employee representing the facilities will only have to attend the Environmental Stewardship Short course once, but a separate Environmental Stewardship Farm Management Plan and associated documents will have to be completed for each facility where livestock are kept.

4. Re-certification - Periodic re-certifications following the third party on-site evaluation protocol described above will be necessary for a producer to maintain his or her Environmental Stewardship Certification as current. The frequency of these re-certifications will be determined as part of the policy and procedure development following the pilot project. In the event that the on-site evaluation reveals circumstances which need to be corrected, the evaluator will leave an itemized list of corrections and will arrange for a subsequent re-evaluation.

5. Quality Control of Evaluation Service - Inspectors from regulatory agencies may sometimes accompany the certification evaluators to observe the quality of the evaluation. A producer has the right not to participate in these joint training exercises. Nothing in this provision limits the ability of a regulatory agency to conduct inspections as authorized by applicable laws.

VI. Obligations of the California Dairy Quality Assurance Program

1. The CDQAP will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.
2. The CDQAP will fund, implement and promote a program which will make Environmental Stewardship workshops available to any producer, regardless of marketing or service organization affiliation. The Environmental Stewardship program has established a goal of having 50% of all producers trained within 24 months of the signing the Partnership Agreement.

3. The CDQAP will fund, implement and promote a program by which any producer, regardless of marketing or service organization affiliation, can voluntarily have his or her facility evaluated and certified.

4. The CDQAP will be the lead organization coordinating the efforts of the various state, federal, industry and academic partners. This coordination will include, but is not limited to, matters related to training, educational materials, and funding.

5. The CDQAP will be the lead organization responsible for the maintenance of routine communications between the organizations participating in this Partnership Agreement. This will include but is not limited to progress reports, scheduling, and minutes of meetings.

6. The CDQAP will be the lead organization responsible for communication of the goals, requirements and benefits of the Environmental Stewardship program to the state's producers.

VII. Obligations of University of California Cooperative Extension

1. University of California Cooperative Extension (UCCE) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. UCCE will make a dairy environmental workshop available to every dairy producer in California, regardless of marketing or service organization affiliation. The Environmental Stewardship program has established a goal of having 50% of all producers trained within 24 months of the signing of the Partnership Agreement. Attendance by a producer in an educational stewardship short course does not require that he or she participate in an on-farm certification. However, both workshop training and on-site certification are prerequisites for a producer to become certified in the environmental stewardship program. UCCE will work with all partners to ensure that the content of the short course is consistent and current with all federal, state, regional and local environmental regulations.

3. Listings of successful completion by a producer in an environmental stewardship short course and on-site certification will be kept by UCCE and provided to all organizations participating in this agreement. All reports resulting from these data will prominently state that "A dairy's lack of participation or certification in this program does not necessarily imply that the facility is out of compliance with any local, state or federal environmental regulations."

4. With the assistance of the other partners, UCCE will compile a central databank of information regarding environmental regulations, interpretation of those regulations, emerging technologies, and educational materials.
5. UCCE will organize the training of the third party evaluators and assist in conducting quality assurance checks to ensure that the on-site evaluations assist producers in meeting all state, federal, regional, and local environmental regulations.

6. UCCE will create and distribute additional materials ("Updates") based on Notices of Violation and Cease and Desist Orders and other information supplied by other partners.

VIII. Obligations of the California Department of Food and Agriculture

1. The California Department of Food and Agriculture (CDFA) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. The CDFA will organize a limited-scale pilot program for third party on-site evaluations. The purpose of this pilot project will be to assess the adequacy of the uniform inspection tool in evaluation of a dairy. CDFA will be assisted in this project by the other partners. Other interested parties such as the California Regional Water Boards and the Department of Health Services will be invited to participate in both the pilot program and the development of the certification policies and procedures. The pilot project is anticipated to take approximately six months. At the end of the pilot project CDFA will report its findings and recommendations back to the partners. At that time, all partners will develop policies and procedures related certification of producers. The policies and procedures will be agreed to by unanimous consent all partners prior to their implementation.

IX. Obligations of the California Environmental Protection Agency and the State Water Resources Control Board

1. California Environmental Protection Agency (Cal-EPA) and the State Water Resources Control Board (SWRCB) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. SWRCB will designate a single representative within its organization to answer questions regarding the appropriateness of specific dairy practices. Responses to these questions will take place within a timely fashion with a goal of a response time of not more than five working days.

3. Cal-EPA and SWRCB will share with other partners changes in policies, guidance and existing regulations at the same time and in the same manner as the rest of the public prior to implementation.

4. Copies of Notices of Violation, Cease and Desist Orders and other regulatory actions will be made available to the partners and the public to the extent authorized by state "sunshine" laws.
5. Cal-EPA and SWRCB will assist UCCE in the creation of environmental stewardship educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

6. Cal-EPA and SWRCB will consider the certification status of a dairy when scheduling routine inspections. The Cal-EPA and SWRCB maintain their authority to enter, inspect or otherwise obtain information regarding any facility in any situation to the extent authorized by the applicable laws for the purposes outlined in those laws. This includes (but is not limited to) complaints or requests for inspections from public sources or private parties, on-going inspections or compliance orders, or any other reason which leads the Cal-EPA or SWRCB to suspect that a facility is not in compliance with state or federal regulations.

7. Cal-EPA and SWRCB will be the lead entities in coordinating the compilation of inspection protocols related to environmental regulations.

8. Cal-EPA and SWRCB will be the lead entities in coordinating the establishment of a check-list to be used by the third party during on-site evaluation. This evaluation check list will assist third party evaluators in determining whether they believe the facility meets federal, state, regional and local environmental regulations to the extent possible given differences in geographic and regulatory locations. This check list will not interfere with any agency’s statutory obligations. A facility’s compliance with the check list will not constitute any agency certification of compliance with any federal, state, regional or local environmental laws. Cal-EPA and SWRCB will work to make this check list explicit and clear enough for an average producer to understand.

9. Cal-EPA and SWRCB will be the lead entities in the organization of educational workshops designed to train and evaluate employees of the third party on-site evaluation organization in the use of the check-lists described above.

10. Cal-EPA and SWRCB will take any necessary steps to ensure that all agencies under its organizational umbrella, (OERHA, CIWMB, regional water boards etc.) are aware of and support the obligations undertaken pursuant to this agreement.

X. Obligations of the California Resources Agency and the Department of Fish and Game

1. The California Resources Agency and the California Department of Fish and Game (CRA-DFG) will support the goals and activities of this agreement as outlined in the above sections 1 (Agreement to Establish Partnership), 11 (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. CRA-DFG will designate a single representative within its organization to answer questions regarding the appropriateness of specific dairy practices.

3. CRA-DFG will cooperate with other partners in communicating changes in existing laws or regulations or their interpretation to the other partners. CRA-DFG will assist the partners in integrating these changes or interpretations into the uniform dairy evaluation tool.

4. Copies of Notices of Violation, and other regulatory actions will be made available to the partners. These data will assist the partners in defining future education and training efforts.
5. Utilizing the data listed above (paragraphs 2, 3 and 4), CRA-DFG will assist UCCE in the creation of educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

6. CRA-DFG will assist Cal-EPA and SWRCB in the processes described above in Section IX, Paragraphs 7, 8, 9. This includes assisting in the establishment of a set of uniform inspection procedures, establishment of a check-list to be used by the third party during on-site evaluation organization, and organization of educational workshops designed to train and evaluate employees of the third party on-site evaluation organization.

7. CRA-DFG will take any necessary steps to ensure that all agencies under its organizational umbrella are aware of and supportive of CRA-DFG's obligations in this agreement.

XI. Obligations of the USDA Animal Plant Health Inspection Service (California office)

1. The USDA Animal Plant Health Inspection Service, Veterinary Services, California office, (APHIS) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional, and local environmental regulations.

2. APHIS will assist in providing appropriate personnel and funding when necessary to conduct research projects, educational seminars, and general guidance.

3. APHIS personnel are available as in all cooperative programs to assist in all activities identified for CDFA.

XII. Obligations of the USDA Natural Resource Conservation Service

1. The USDA Natural Resource Conservation Service (NRCS) will support the goals and activities of this agreement as outlined in the above sections I (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional, and local environmental regulations.

2. NRCS will continue to provide technical assistance to dairy operators

3. NRCS will continue to pursue additional avenues for technical assistance to dairy operators including the development of the consultant/emp advisor industry.

4. NRCS will continue to participate in the development of technical procedures, training materials, and educational materials.
XIII. Obligations of the USDA Farm Services Agency

1. The USDA Farm Services Agency (FSA) will support the goals and activities of this agreement as outlined in the above sections 1 (Agreement to Establish Partnership), II (Partnership Purpose and Goals), and III (Program Areas and Activities). The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

XIV. Obligations of the US Environmental Protection Agency (Region 9)

1. The United States Environmental Protection Agency, Region 9 (US-EPA), supports the goals and activities of this partnership agreement, to the extent that the agreement does not conflict with US-EPA’s authority and obligation to implement federal laws and regulations including laws related to funding and appropriations. The primary responsibility of all partners is to communicate with the other partnering organizations to assist producers in meeting a generally understood set of federal, state, regional and local environmental regulations.

2. US-EPA’s access to documents and confidentiality and disclosure of records shall be governed by applicable federal law.

3. US-EPA will designate a lead representative and several alternates to answer questions regarding the appropriateness of specific dairy practices. Responses to these questions will take place within a timely fashion and as quickly as possible.

4. US-EPA will share with other partners changes in policies, guidance and existing regulations at the same time and in the same manner as the rest of the public. Such input shall in no way be construed as surrendering existing statutory or regulatory authority of US-EPA.

5. Copies of Notices of Violation, Administrative Compliance Orders and other regulatory actions will be made available to the partners at their specific request after they are finalized and made public as authorized by the Freedom of Information Act (FOIA). These data will assist the partners in defining future education and training efforts.

6. US-EPA will assist UCCE in the creation of environmental stewardship educational materials. These materials may include fact sheets, question and answer sheets, risk evaluation tools etc.

7. US-EPA will consider the certification status of a dairy when scheduling routine inspections. US-EPA maintains its authority to inspect any facility to the extent authorized by law.

8. US-EPA will coordinate with appropriate State agencies when conducting routine civil inspections. At its discretion, US-EPA may inform crop advisors and other county officials prior to conducting such inspections in their county.

9. US-EPA will be a lead entity in coordinating the compilation of inspection protocols related to environmental regulations.

10. US-EPA will assist in establishing materials (such as an inspection check-list to be used by the third party during on-site evaluation) that will assist the third party evaluator in determining whether they believe the facility is in compliance with applicable environmental statutes. A facility’s compliance with a check list will not constitute agency certification of compliance with any federal, state, or local environmental laws.

11. US-EPA will take any necessary steps to ensure that all divisions within the Regional Office are aware of and support the obligations described in this agreement.
XV. General Provisions of the Agreement

1. Obligations of the public and private signatories of this agreement are limited to the elements of the agreement itself. Participation in this Environmental Stewardship agreement in no way obligates collaborating organizations or individual producers to participate in other components of the CDQAP (such as the food safety and animal health/welfare modules).

2. Nothing in this agreement shall be construed as surrendering existing statutory or regulatory authority of any party.

3. Nothing in this agreement shall be construed to release a dairy operator from complying with the applicable federal, state, regional or local environmental statutes, regulations, permits, or consent orders.

4. This agreement may be amended through mutual agreement of the parties.

5. Individual partners may unilaterally withdraw from the partnership agreement following a thirty day notice and explanation of the reasons for withdrawal given at a meeting of the full partnership.
PRODUCTION AGRICULTURE - VOLUNTARY (INCENTIVE BASED) AIR QUALITY COMPLIANCE PROGRAM
Agricultural Air Quality Task Force
November 10, 1999

PURPOSE: Provide recommendations to USDA and USEPA requesting that a Voluntary (Incentive Based) Air Quality Compliance Program be developed in accordance with the following guiding principles:

INTRODUCTION
Agricultural field operations are perceived to be significant sources of PM_{10}. In areas that are classified as nonattainment, states are required to bring the areas into attainment in a time frame specified by the Clean Air Act (CAA). If a time line is not met, the state is subject to penalties such as withholding of federal highway funds, offsets, and Federal Implementation Plans (FIPs).

In "moderate" and "serious" nonattainment areas, all area source agricultural operations that are perceived to contribute to the ambient concentration of PM_{10} will be required to implement "Reasonably Available Control Measures (RACM)s and "Best Available Control Measures (BACM)s, respectively. No currently guidance exists on RACM and BACM for agricultural operations. The difficulties with specifying control measures for area sources of PM_{10} are the lack of good scientific data on the quantity of the PM_{10} reductions associated with specific "RACM/BACM". In order to appropriately develop guidance for agricultural operations, the following research is needed:

- Define appropriate and effective PM_{10} control measures (potential RACM/BACMs) for agricultural operations that are economically and technologically feasible;
- Quantify PM_{10} reductions resulting from the utilization of each proposed RACM/BACM; and
- Develop accurate emissions inventories for agricultural operations.

In the interim, States must include in their State Implementation Plans (SIPs) actions that will bring nonattainment areas into attainment within the time frame specified by the CAA. The Agricultural Air Quality Task Force (AAQTF) recommends that the available control measures (potential candidates for RACM/BACM) be based on the Conservation Management Practices (CMP) compiled by USDA.

VOLUNTARY COMPLIANCE PROGRAM RECOMMENDATIONS
The AAQTF considers that voluntary compliance programs are the appropriate strategy for agriculture. The AAQTF is proposing that voluntary compliance programs be used by air pollution regulatory agencies for reductions of PM_{10}
from agricultural operations in areas classified as nonattainment. The goal of these voluntary, incentive-based programs is to provide significant reductions of PM_{10} emissions from agricultural operations while sustaining long-term agricultural production. In order for EPA to utilize this policy, the USDA incentive-based programs must include accountability and backstop provisions. Accountability would encompass verification of participation in the program by NRCS or appropriate agency. (Farmers will self-certify and NRCS will provide verification of percent application every third year or as appropriate.) Accountability would also include adequate record keeping of plans and participation by USDA. Backstop would be a failure to achieve participation credited in the SIP which would result in a SIP Calla and could result in a regulatory approach by the state which could regulate individual agricultural operations.

Although the motivation for this program is to address PM_{10} regulatory procedures, it is anticipated that this voluntary compliance program could also be used for other regulated pollutants attributed to agricultural operations.

As part of this program, the AAQTF proposes the following:

- A guidance document for agriculture production be developed that would include proposed RACM/BACMs and estimated reductions of PM_{10} associated with implementation of each abatement strategy. It is anticipated that RACM/BACM will need to be determined on a site specific basis. (A RACM/BACM may be appropriate for one location and not appropriate for another.) Provisions will be made to facilitate the incorporation of current research findings into this guidance document.

- Local elected officials from the soil and water conservation districts as agreed to in the USDA/EPA Memorandum of Understanding (MOU) may administer the voluntary compliance program with technical assistance, education and training provided by the Natural Resources Conservation Service (NRCS), Cooperative State Research, Education, and Extension Service (CSREES), land grant universities, and the Agricultural Research Service (ARS).

- Appropriate resources should be provided to the local soil and water conservation districts and NRCS personnel.

- SIP credits should be allowed based on the rate of participation (percentage of land mass and/or percentage of cooperators participating) and should be based on certification by officials of the conservation district on an annual basis.

- There should be no additional record keeping and reporting requirements on the cooperators beyond that required by the USDA programs.

- The success of this policy will depend upon the states ability to comply with the SIP.

- If agricultural operations are utilizing economically and technologically feasible control measures, the intent of this policy is not to place demands that will result in adverse impacts on those cooperators.
ORDINANCE NO. 587

AN ORDINANCE OF THE COUNTY OF KINGS
ESTABLISHING WATER WELL STANDARDS
IN ACCORDANCE WITH CALIFORNIA
WATER CODE SECTION 13801

The Board of Supervisors of the County of Kings ordains as follows:

SECTION 1. Chapter 14A of the Kings County Code of Ordinances is hereby repealed effective August 29, 2000.

SECTION 2. Chapter 14A of the Kings County Code of Ordinances is hereby added to read as follows:

"Chapter 14A
WATER WELLS
ARTICLE I. GENERAL PROVISIONS

Sec. 14A-1. Policy.

It is the purpose of this Chapter to protect the health, safety, and general welfare of the people of Kings County and of the State of California by ensuring that the ground waters of Kings County and of this state will not be polluted or contaminated. To this end, minimum requirements are contained in this Chapter for construction, reconstruction, repair, and destruction of water wells, cathodic protection wells, and monitoring wells.

Sec. 14A-2. Definitions.

Except as otherwise required by the context of this Chapter, the terms used in this Chapter shall have the same meaning as in Chapter 10 of Division 7 of the California Water Code and the Department of Water Resources Bulletin 74-81 and subsequent supplements or revisions thereto, including, but not limited to, Department of Water Resources Bulletin 74-90.

(a) "Abandoned Well" shall mean a well whose use has been permanently discontinued.

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(b) "Applicant" shall mean the owner of the property upon which a well is located, or proposed to be located, or a licensed well driller or other person duly authorized in writing to act on behalf of the property owner.

(c) "Board" shall mean the Kings County Board of Supervisors.

(d) "Building Official" shall mean the chief building official of the County of Kings, or his designee.

(e) "Cathodic Protection Well" as used in this chapter, means any artificial excavation in excess of fifty feet deep constructed by any method for the purpose of installing equipment or facilities for the protection of metallic equipment in contact with the ground.

(f) "Compliance Agency" shall mean the Kings Public Works Department.

(g) "Compliance Officer" shall mean the Kings County Public Works Director, or his designee.

(h) "Inactive Well" shall mean a well the use of which has been temporarily discontinued and has not been abandoned.

(i) "Monitoring Well" as used in this chapter, means any artificial excavation by any method for the purpose of monitoring fluctuations in groundwater levels, quality of underground waters, or the concentration of contaminants in underground waters.

(j) "Person" shall mean any person, firm, corporation or governmental agency, to the extent authorized by law.

(k) "Repair" does not include ongoing well and pump maintenance or minor repairs, including, but not limited to, pulling of the pump and pump column for repair or modification of the pump, video taping of the well casing, cleaning of encrusted or plugged perforations, swedging of the well casing, jetting and conducting pump tests.

(l) "Well or Water Well" as used in this chapter, means any artificial excavation constructed by any method for the purpose of extracting water from, or injecting water into, the underground. The definition does include Monitoring Wells. This definition shall not include: (a) oil and gas wells, or geothermal wells constructed under the jurisdiction of the Department of Conservation, except those wells converted to use as water wells; or (b) wells used for the purpose of (1) dewatering excavation during construction, or (2) stabilizing hillsides or earth embankments; or (c) potholes, drainage trenches or canals, waste water ponds, stock ponds, shallow root zone piezometers and similar devices, or evaporation or sinking basins or similar excavations.
Sec. 14A-3. Interpretation:

(a) Tense, Gender or Number. Words used in the present tense include the future as well as the present. Words used in the masculine gender include the feminine. The singular number includes the plural, and the plural the singular.

(b) Section Headings. When contained in this Chapter, section headings shall not be deemed to govern, limit, modify, or in any manner affect the scope, meaning, or intent of the provisions of this Chapter.

ARTICLE II. PERMITS


(a) When Required. No person shall dig, bore, drill, deepen, modify, repair, or destroy a water well, cathodic protection well, observation well, monitoring well or any other excavation that may intersect ground water without first applying for and receiving a permit as provided in this Chapter unless exempted by law.

(1) Applicant. An application for a permit may be filed by the owner of the property upon which the well is located, or proposed to be located, or by a licensed well driller or any other person duly authorized in writing by the property owner to apply for such permit.

(2) Persons Permitted to Work on Wells. All construction, reconstruction, or destruction work on wells shall be performed by a person who possesses an active C-57 contractor's license in accordance with the provisions of the California Business and Professions Code, Section 7000, et. seq. and Water Code Section 13750.5.

(3) Registration Requirement. All properly licensed persons who do work on wells under the provisions of this Chapter must register with the Compliance Agency under procedures established by the Compliance Agency.

(b) Monetary Penalty for Failure to Obtain Permit. Any person who shall commence any work for which a permit is required by this Chapter without having obtained a permit shall be required, if subsequently granted a permit for this work, to pay double the standard permit application fee.

(c) Emergency Work. The above provisions shall not apply to emergency work required on short notice to maintain drinking water or agricultural supply systems. In such cases, the person responsible for the emergency work shall:
(1) Apply for a permit within three working days after commencement of emergency work; and

(2) Satisfy the Building Official that such work was urgently necessary; and

(3) Demonstrate that all work performed was in conformance with the technical standards as designated in Article III hereof.

(d) Fees. Application, permit and other fees may be set by the Board from time to time by ordinance or resolution. The Board may provide for the waiver of fees under appropriate circumstances.


Applications for permits shall be made to the Building Official on forms approved by the Building Official and shall contain all such information that the Building Official and the Compliance Agency require to accomplish the purposes of this Chapter and state law. The application shall be accompanied by the required filing fee. If the Building Official finds the application contains all necessary information, he shall process the application as set forth in this Article.

(a) Review Process. Prior to approval of a permit, and within two days of receipt of a complete permit application, the Building Official shall submit a copy of the permit application to the Compliance Agency for review and comment. The Compliance Agency shall comment in writing or electronically to the Building Official, if at all, within five calendar days of receipt of the copy of the permit application.

(b) The Building Official shall review the comments, if any, received from the Compliance Agency and any other agency to which the application was submitted. Within ten calendar days of the submission of the permit application for comment, and after review of any comments received, the Building Official shall determine whether the application complies with this Chapter and with State law. If it so complies, the Building Official shall issue to the applicant a comprehensive permit containing such conditions as are necessary to fulfill the purposes of this Chapter and State law.

(c) Notice To Compliance Agency. Immediately upon issuance of a permit, the Building Official shall transmit a copy of the permit to the Compliance Agency. Thereafter, except for inspections as set forth in Section 14A-50 below, the Compliance Agency shall be responsible for enforcement of the permit and for ensuring compliance with the permit terms and conditions and with the provisions of this Chapter.
Sec. 14A-23. Permit Conditions.

(a) Limitations. When the Building Official issues a permit pursuant to this Chapter, he may condition the permit in any manner necessary to carry out the purposes of this Chapter and State law. Conditions may include, but are not limited to, such quantity and quality testing methods as the Building Official or the Compliance Agency finds necessary.

(b) Performance Bond. The Building Official may require a performance bond as a condition to issuance of the permit.

(c) Proper Disposal of Drilling Fluids. The permit shall contain a clause requiring the safe and appropriate handling and disposal of drilling fluids and other drilling materials used in connection with the permitted work.

(d) Abandoned Wells. As a condition to the issuance of a construction or reconstruction permit, any known abandoned wells on the property shall be destroyed in accordance with the Standards provided in this Chapter.

(e) Posting of Permit. It shall be the responsibility of the permittee to maintain a copy of the permit on the drilling site during all stages of construction, reconstruction or destruction.


The Building Official shall deny an application for a permit if, in his judgment, the issuance of the permit would result in a violation of this Chapter or State law or regulations. The denial of a permit may be appealed as set forth in Section 14A-27.

Sec. 14A-25. Permit Expiration.

The permittee shall complete the work authorized by the permit within 180 days of the date of issuance of the permit. Upon written application, and if there have been exceptional circumstances, the Building Official may grant the applicant one extension of time. Upon the expiration of the permit, no further work shall be done unless and until the applicant has received an extension or a new permit.

Sec. 14A-26. Permit Suspension and Revocation.

(a) Circumstances for Such Action. The Building Official or the Compliance Agency may suspend or revoke any permit issued pursuant to this Chapter whenever it finds that the permittee has violated any of the provisions of this Chapter or State law or regulation, has not complied with permit terms or conditions, or has misrepresented any
material fact in his application, or any supporting documents, for such a permit. Prior to ordering any such suspension or revocation, the Building Official or the Compliance Agency shall give the permittee an opportunity for a hearing thereon, after reasonable notice. The hearing shall be before the Building Official or the Compliance Agency head or his designated representative. An appeal may be made as set forth in Section 14A-27 below.

(b) Consequences. No person whose permit has been suspended or revoked may continue to perform the work for which the permit was granted. In the case of suspension, the work may be resumed when the permit has been reinstated by the Building Official or the Compliance Agency. In the case of revocation, a new permit must be applied for and obtained prior to resumption of work.

(c) Ordered Additional Work. Upon suspending or revoking any permit, the Building Official or the Compliance Agency may order the permittee to perform any work reasonably necessary to protect the underground waters from pollution or contamination, if any work already done by the permittee has left a well in such condition as to constitute a hazard to the quality of the underground waters. No permittee or person who has held any permit issued pursuant to the Chapter shall fail to comply with any such order.

Sec. 14-27. Permit Appeals.

(a) Right of Hearing. Any person whose application for a permit has been denied, or granted conditionally, or whose permit has been suspended or revoked, or whose variance request has been denied, may appeal to the Board, in writing, within ten days after any such denial, conditional granting, suspension, or revocation. Such appeal shall specify the grounds upon which it is taken, and shall be accompanied by the applicable filing fee as established by the Board. The clerk of the Board shall set such appeal for hearing at the earliest practicable time, and shall notify the appellant and the Building Official or the Compliance Agency, in writing, of the time so set at least five days prior to the hearing.

(b) Action by the Board. After such hearing, the Board may reverse, wholly or partly, may modify, or may uphold the order or determination appealed from.

ARTICLE III. WELL STANDARDS

Sec. 14A-31. Well Standards.

(a) State Standards. Except as otherwise specified, the standards for the construction, repair, reconstruction, or destruction of wells under this Chapter shall be as set forth in California Department of Water Resources Bulletin 74-81 “Water Well
Standards, State of California" except as modified by supplements and revisions thereto, including, but not limited to, Bulletin 74-90. Such standards are referred to in this Chapter as the "Standards".

(b) Local Regulations. The Board may by resolution adopt regulations designed to implement this Chapter, but only to the extent that such regulations are not inconsistent with State laws, regulations or Bulletins 74-31, 74-90 and amendments thereto.

Sec. 14A-32. Variances.

Based upon the recommendation of the Compliance Agency, the Building Official shall have the power to grant a variance from any provision of the standards referred to above and to prescribe alternative requirements in their place, if both the following conditions are met:

(a) Special Circumstances. There must be, in a specific case, a special circumstance where practical difficulties or unnecessary hardship would result from the strict interpretation or enforcement of any standard.

(b) Intent of Chapter Not Compromised. The granting of such a variance is consistent with the purposes of this Chapter.

ARTICLE IV. SPECIAL PROTECTION AREAS

Sec. 14A-40. Special Ground Water Protection Area.

The Compliance Agency may designate areas where ground water quality problems are known to exist and where a well will penetrate more than one aquifer. The Compliance Agency may require in these designated areas special well seals to prevent mixing of water from several aquifers. Where an applicant proposes well construction, reconstruction, or destruction work in such an area, the Compliance Agency may require the applicant to provide a report prepared by a Registered Geologist or Registered Civil Engineer (California Business and Professions Code Sections 7850 and 6762 respectively) that identifies all strata containing poor quality water and recommends the location and specifications of the seal or seals needed to prevent the entrance of poor-quality water or its migration into other aquifers.

(a) Designation Procedures. The Compliance Agency shall not designate a special groundwater protection area without obtaining the approval of the Board of Supervisors. Prior to designating any area as a "special ground water protection area" within the meaning of this Chapter, the Compliance Agency shall hold at least one public hearing before the Board on the issue of designation of such area. Notice of the public
hearing shall be published in a daily newspaper of general circulation published in Kings County once a week for two successive weeks with the last date of publication occurring at least ten days prior to the hearing date. In addition, the Compliance Agency shall provide written notice by mail to all owners of property directly overlying the proposed special groundwater protection area. For the purposes of this section, the owners of property shall be those shown on the Kings County Assessment Roll.

ARTICLE V. INSPECTIONS

Sec. 14A-50. Inspections of New Permitted Well Construction.

The Building Official or his designee shall make an inspection of the annular seal construction work. In addition, he may make an initial inspection of each proposed drilling site, an inspection at the completion of the work, and inspections at such other times as it seems appropriate.

(a) Initial Inspection. Upon receipt of a copy of an application, the Building Official may make an inspection of the drilling site prior to the issuance of a well permit. The purpose of this inspection is to determine whether there are any site conditions which would require the Building Official to do any of the following:

(1) Relocation of Drilling Site. Require relocation of the drilling site should the location shown on the permit application be too close to potential sources of pollution.

(2) Additional Conditions. Establish any additional conditions if needed to remediate any previously unknown ground water quality protection problems.

(b) Inspection of Well Seal. The Building Official shall inspect the annular space grout depth prior to the sealing and shall inspect the construction of the annular seal during its placement. Except as set forth in Section 14A-21(c) above and subsection (b)(2) below, no seal shall be tremied or placed unless the Building Official is present and until permission to proceed is given.

(1) Required Notice. The permittee shall notify the Building Official a minimum of forty-eight hours prior to sealing the annular space. Drillers who anticipate completing a well in less than one day shall notify the Building Official twenty-four hours prior to commencement of drilling and provide the anticipated time to commence the sealing of the annular space. Permittees shall make best efforts to schedule inspections on days other than Saturdays, Sundays and holidays. If the permittee is unable to meet this requirement, he shall comply with the self-certification process established by the Building Official.
(2) Should Building Official Fail to be Present. If the Building Official is unable to be present at the time the annular seal is to be tremied or placed, the driller shall seal the well in accordance with the standards of this Chapter, State laws and regulations, and any permit conditions. At the time the Building Official first learns that he will be unable to be present, he shall give permission to proceed in his absence, subject to the requirements set forth herein.

(c) Final Inspection. If requested by the Building Official, the driller shall notify the Building Official within seven days of the completion of their work at each drilling site. The Building Official may make a final inspection after completion of the work to determine whether the well was completed in accordance with this Chapter.

Sec. 14A-51. Inspections of Abandoned Well Destruction.

(a) The Building Official or his designee shall make an inspection of the sealing of all abandoned wells. In addition, it may make an initial inspection of each proposed destruction site, an inspection at the completion of the work, and inspections at such other times as it deems appropriate.

(b) Inspection of Well Sealing. The Building Official shall inspect any well which is proposed for destruction and shall inspect the construction of each seal during its placement. Permitees shall make best efforts to schedule inspections on days other than Saturdays, Sundays and holidays. If the permittee is unable to meet this requirement, he shall comply with the self-certification process established by the Building Official.

(1) Required Notice. The permittee shall notify the Building Official a minimum of forty-eight hours prior to placing each seal in the well.

(2) Should Building Official Fail to be Present. If the Building Official is unable to be present at the time the well is sealed, the driller shall seal the well in accordance with the standards of this Chapter, State laws and regulations, and any permit conditions

Sec. 14A-52. Waiver of Inspections.

The Building Official, after consultation with the Compliance Agency, may waive inspections should any of the following conditions exist:

(a) Well Inspected by Other Agencies. Inspections may be waived where the work will be inspected by the staff of the California Regional Water Quality Control Board or the California Department of Health Services if these designated agencies will inspect and report to the Building Official on all drilling features required by the Standards.
(b) Monitoring Wells Under Specified Conditions. Inspections may be waived for monitoring wells that will penetrate only aquifers containing degraded waters or will penetrate only formations that normally contain no water.

(c) Drilling Sites Known to Have No Threats to Ground Water Quality. Initial inspections may be waived when the drilling site is well known to the Building Official and it is known that no significant threats to groundwater quality exist in the area.

ARTICLE VI. REPORTS

Sec. 14A-60. Completion Reports.

The driller shall provide the Compliance Agency a completion report within thirty days of the completion of any well construction, reconstruction, repair or destruction job.

(a) Submittal of State “Report of Completion”. A copy of the “Report of Completion” (Water Well Drillers Report, Department of Water Resources Form 188) required by California Water Code Section 13751 shall be submitted by the permittee to the Compliance Agency within thirty days of construction, alteration, or destruction of any well. This report shall document that the work was completed in accordance with the Standards and all additional permit conditions. This section shall not be deemed to release any person from the requirement to file said report with the state Department of Water Resources.

(b) Confidentiality of Report. In accordance with California Water Code Section 13752, reports shall be kept confidential. Reports shall be made available to any person who obtains written authorization from the owner of the well.

(c) Other Agency’s Requirements. Nothing in this Chapter shall be deemed to excuse any person from compliance with the provisions of California Water Code Sections 13750 through 13755 relating to notices and reports of completion, or with any other federal, State, or local reporting regulations.

Sec. 14A-61. Reports to the Regional Board.

Pursuant to California Water Code Section 13225 (c), the Compliance Agency shall submit a report, not less than annually, to the Central Valley Regional Water Quality Control Board. This report shall contain the following data, unless the Regional Board determines a lesser amount of information is necessary:

(a) Wells Constructed or Destroyed. The number of wells constructed or destroyed.

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(b) Abatement Actions. Descriptions of all well destructions undertaken by the Compliance Agency using its regulatory authority under nuisance abatement powers.

(c) Variances Granted. A description of each specific case where variances were granted and the circumstances that made a variance necessary.

(d) Inspection Waivers Granted. A description of each specific case where an inspection was waived and the circumstances that made the waiver necessary.

ARTICLE VII. ENFORCEMENT

Sec. 14A-70. Right of Entry and Inspection.

(a) Representatives of the Compliance Agency and/or the Building Official shall have the right to enter upon any premises at all reasonable times to make inspections and tests for the purpose of enforcement and administration. If any such premises are occupied, he shall first present proper credentials and request entry. If the same is unoccupied, he shall first make a reasonable effort to locate the owner or other person having charge or control of same and request entry. If such entry is refused, he shall have recourse to such remedies as are provided by law to secure entry.

(b) As a condition of the approval of any permit issued under the terms of this Chapter, the permitted party shall sign a statement expressly stating that the Compliance Agency and/or the Building Official shall have the right to enter upon the premises to make inspections and tests for the purpose of enforcement and administration of this Chapter and to ensure compliance with the permit terms and conditions.

Sec. 14A-71. Abatement of Abandoned Wells.

All persons owning an Abandoned Well as defined in this Chapter shall destroy it in accordance with the standards established herein, except those wells excluded by the California Health and Safety Code or other applicable provision of law.

(a) Abatement by County as Nuisance. Abandoned Wells which are not destroyed in accordance with the terms of this Chapter, or in accordance with any applicable permit condition imposed by the Building Official, are hereby declared to be public nuisances which may be abated by the County in accordance with Article IV of Chapter 14 of the Kings County Code of Ordinances.

(b) Maintenance of Inactive Well. In accordance with Section 115700 of the California Health and Safety Code, as evidence of intention for future use, the well owner shall properly maintain an Inactive Well in compliance with the following requirements:
(1) The well shall not allow impairment of the quality of water within the well or ground water encountered by the well.

(2) In order to prevent unauthorized access, to prevent a safety hazard to humans or animals, and to prevent illegal disposal of wastes or other contaminated materials in the well, the top of the well or well casing shall be provided with a cover that is secured by a lock or other security device preventing the use of the cover without the use of equipment or tools. In order to prevent entry of surface waters, the cover shall be watertight where the top of the well casing or other surface openings to the well are below either ground level or known levels of flooding or irrigation practices. Regardless of the position of the top of the well casing, the cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well shall suffice as a cover if it is in compliance with the above provisions.

(3) An Inactive Well shall be marked so as to easily visible and located and labeled so as to be easily identified as a well.

(4) The area around an Inactive Well shall be kept clear of brush, debris and waste materials.

(5) Biannually, on or before December 31 of every other year during which an Inactive Well has been continuously maintained as such, the well owner shall submit a written, signed statement to the Compliance Officer identifying the well, indicating its status as an Inactive Well, and stating that the above requirements have been met.

Sec. 14A-72 Criminal and Civil Enforcement.

(a) Violation a Misdemeanor. Any person who violates any of the provisions of this Chapter is guilty of a misdemeanor, and upon conviction thereof is punishable by such penalties as the Board shall from time to time set by ordinance.

(b) Civil Enforcement as a Nuisance. Wells constructed, reconstructed, deepened, or destroyed which are not constructed, reconstructed, deepened, or destroyed in accordance with the terms of this Chapter, or in accordance with any applicable permit condition imposed by the Building Official, are hereby declared to be public nuisances which may be abated in accordance with the provisions of Article IV of Chapter 14 of the Kings County Code of Ordinances. The property owner or his agent may abate any such public nuisance described hereinabove at any time prior to commencement of actual abatement by or at the direction of the Compliance Agency or the Building Official.
SECTION 3. This ordinance shall take effect and be in force thirty (30) days after its adoption, and, before the expiration of fifteen (15) days after its passage, a summary of this ordinance shall be published once with the names of the members of the Board of Supervisors voting for and against the same in the Hanford Sentinel, a newspaper of general circulation published in the County of Kings.

The foregoing ordinance was introduced at a meeting of this Board of Supervisors of the County of Kings held on August 15, 2000, and adopted at a meeting held August 29, 2000, by the following vote:

AYES: TONY OLIVEIRA, JOE NEVES, JON RACHFORD, TONY BARBA, ALENE TAYLOR

NOES: NONE

ABSENT: NONE

/s/ Alene Taylor
Chairman of the Board of Supervisors
County of Kings, State of California

WITNESS my hand and seal of said Board of Supervisors this 29th day of August, 2000.

/s/ Rose Martinez
Clerk of said Board of Supervisors
Water Well Standards: State of California

Bulletin 74-81
December 1981
Department of Water Resources
Bulletin 74-81

Water Well Standards: State of California

December 1981
FOREWORD

Our ground water resources are becoming increasingly important to all Californians. In an ordinary year, about 40 percent of the water used in the State is derived from underground sources. During the 1976-77 drought, however, that figure rose to 53 percent. To ensure the continued utility of our underground resources, they must be protected. Standards for both the construction of water wells and the destruction of abandoned wells can help protect ground water quality.

Furthermore, deficiencies in the design and construction of wells usually result in higher operating and maintenance costs. The establishment and implementation of well standards in an area provide more assurance that wells are likely to require less maintenance and will have longer useful lives.

Since the initial printing of these standards in February 1968, 30 counties and 132 cities have enacted ordinances, based on Bulletin 74, governing the construction, alteration, and destruction of all water wells within their boundaries. (At that time, three other counties already had ordinances in effect.) These ordinances specify that water wells be constructed, or destroyed when their useful lives are over, in accordance with the guidelines contained in the Department of Water Resources' standards.

Changes in the field of well construction (methods, equipment and materials), together with the experiences of applying the 1968 standards, warrant revising and updating them. As a result, this new edition is being issued. Counties and cities that have not yet done so are urged to consider enacting well construction standards to protect the quality of ground water supplies for the benefit of their citizens. Where standards are in effect, consideration should be given to revising them to reflect the modifications presented in this bulletin.

Ronald B. Robie, Director
Department of Water Resources
The Resources Agency
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The portions of this report pertaining to community water supply wells were prepared in cooperation with Clarence L. Young, Supervising Sanitary Engineer, California Department of Health Services, Sanitary Engineering Section.
CHAPTER I. INTRODUCTION

About 40 percent of the water used in California comes from underground. During the 1976-77 drought the proportion rose to 53 percent. In some locations water from wells or springs is the only water available. The Department estimates that there are 500,000 to 750,000 water wells (irrespective of condition or whether used or idle) scattered throughout the State. Most are situated in the 400 significant ground water basins in California, although many thousands are located in the hilly and mountainous areas. They range from hand dug wells to carefully designed large production wells drilled to great depths.

If our ground water supplies are to remain useful to us, we are obligated to protect their quality. It is ironic that one way in which ground water quality can decline is through the well. This occurs when, because of inadequate construction, wells provide a physical connection between sources of pollution and usable water. The geologic environment has some natural defenses against pollutants, but each time we penetrate that environment, we may carelessly establish avenues for their uncontrolled introduction. Abandoned wells pose a particularly serious threat, not only to ground water quality but also to the safety of humans, especially children, and to animals. Such wells are frequently and conveniently forgotten and once out of mind, there is little chance of preventing them from eventually becoming a problem.

The potential for such problems is growing because the number of wells is increasing. Around 15,000 new wells are constructed each year. In 1977, at the height of the 1976-77 drought, an estimated 28,000 wells (about double an average year) were drilled in the State. The number of wells abandoned each year is not known.

A properly constructed or adequately destroyed well should maintain, as far as practicable, those subsurface conditions which, prior to construction of the well, prevented the entrance of unsanitary and inferior-quality water into usable ground water supplies. Standards for the construction of water wells and for the destruction of so-called "abandoned" wells can be a significant factor in the protection of ground water quality and should contribute to the betterment of the health and welfare of the people of the State.

Impairment of the quality of ground water of the State through improper construction or abandonment of wells has long been one of the concerns of the Legislature. In 1949 it enacted legislation which, among other matters, directed the Department of Public Works to investigate and survey conditions of damage to quality of underground water caused by improperly constructed, abandoned or defective wells and to report to the appropriate regional water pollution control boards its recommendations for minimum
amended (or new) permit is issued a thorough review is made of (a) the location of the well with respect to potential contamination hazards, (b) design and construction of the well necessary to prevent contamination or the exclusion of undesirable water, and (c) the bacterial and chemical quality of the water produced. The Department may issue a permit if it finds that the water "under all circumstances is pure, wholesome, and potable and does not endanger the lives or health of human beings." Specific water quality and monitoring standards have been adopted by regulation. If at any time water produced from an existing well fails to comply with such standards, the Department may require changes or modifications of the well, provisions of appropriate water treatment, or cause the curtailing of use, even destruction of the well, in order to assure a safe supply to the public.

In summary, the responsibility of the Department of Water Resources is to advise the Legislature and appropriate state agencies on the maintenance of ground water quality, including protection against adverse effects caused by improper well construction or the abandonment of wells. This responsibility applies to all wells, irrespective of purpose. The responsibility of the Department of Health Services is to investigate, evaluate, and approve public water supplies including the design and construction of water wells.

This report was prepared by the Department of Water Resources in fulfillment of its responsibilities under the provisions of Section 251 of the Water Code, and in cooperation with the State Department of Health Services.

Statement of the Problem

Wells themselves do not cause ground water quality to deteriorate. Rather, it is inadequate construction, or, in the case of wells that no longer serve a useful purpose, their improper destruction, that can result in the deterioration of ground water quality. Depending on the circumstances, such quality deterioration may affect the water supplying a single well, or if the pollution is substantial, a sizable segment of a ground water basin.

The impairment of water quality in an individual well, or group of wells, is the most common. Ground water supplies have been responsible for a sizable portion of the water-borne disease outbreaks reported in the United States. Most of these outbreaks occurred where wells were so poorly constructed that they allowed contaminants to enter the well. Contaminants entering improperly constructed wells are not limited to disease organisms. There is also a growing number of case histories concerning undesirable chemicals, both toxic and nontoxic, that have gained access to ground water and adversely affected wells a short distance away.

The mechanism of water quality impairment caused by faulty wells affecting large segments of a ground water basin is not well defined. In most instances, a number of factors have been involved; the wells have served primarily to facilitate the impairment. The most noteworthy examples in
Figure 1. AVENUES OF ENTRANCE FOR POLLUTANTS TO WELLS

A. WELL LOCATED TOO CLOSE TO POLLUTION SOURCE
B. ENTRY THROUGH PUMP BASE
C. ENTRY BENEATH PUMP
D. VIA THE ANNULAR SPACE
Irrespective of the probability of occurrence and which form of deterioration takes place, wells should be constructed or destroyed such that they do not contribute to the impairment of the quality of California's ground water supplies. Moreover, while the well construction industry, advisory groups, and regulatory agencies want to protect the quality of the State's ground water supplies as well as assure that wells are adequately constructed, there is no broad, uniform approach for so doing in California. The resolution of this problem requires the development of standards for water well construction and destruction that will ensure the protection of the State's ground waters as they exist in the ground or as they pass through the well for use. Such standards should be capable of execution by the average competent well driller using commercially available equipment and materials, without imposing undue financial burden on the well owner.

Well standards do more than protect the quality of the ground water resource; they also provide a degree of consumer protection. When standards are established and implemented in an area, well owners have more assurance that their wells will be constructed properly. Proper construction could mean less maintenance with an extended well life. Most well owners do not realize that deficiencies in design and construction (including failure to close-off access to pollutants described above) are likely to result in higher operating and maintenance costs.

A subject touched upon earlier is the safety hazard posed by the unused or "abandoned" well. While safety is not a matter involving the maintenance of ground water quality, it should be a concern to all those involved with water wells. Any abandoned excavation is a threat to the safety of people, especially children and animals. Further, State law (Section 24400 of the California Health and Safety Code) requires that abandoned excavations be fenced, covered, or filled. Yet, children (and sometimes adults) and livestock do fall into abandoned wells and other excavations.

By properly destroying abandoned wells, we can easily eliminate this safety hazard.

Developing the Standards

The Department of Water Resources began formulating standards for the construction of water wells and the destruction of abandoned wells shortly after the enactment of Water Code Section 251 in 1949. The Department made a comprehensive survey of existing laws and regulations governing well construction and abandonment in the then 47 other states and in the counties and cities of California. This survey culminated in the publication of "Water Quality Investigations Report No. 9 - Abstracts of Laws and Recommendations Concerning Water Well Construction and Sealing in the United States", April 1955. Although the report is over 25 years old, it remains a useful source of background information. The Department has continued to keep informed of practices in other states, particularly those in which
helpful to describe the areal and vertical extent of geologic materials where sealing is needed to prevent the migration of poor quality water.

Thus, the Department maintained a concurrent and subsequent activity consisting of studies and reports describing the application of standards in designated areas of California. And, in addition to Bulletin 74, the Department issued a number of reports containing well standards for those areas (see Table 1). [1]

The 1981 Edition

The foreword to the 1968 edition stated that:

"Whereas the standards in this report are as final as they can be at the present time, the Department will revise them from time to time. We recognize that, as with other published standards, to be effective and useful they must be revised and updated in light of both changes in practice and degree of success achieved in their application."

Sufficient changes in the field of water well construction and experience with applying the 1968 standards warrant revising them. Foremost among the changes in construction practices are:

1. The development and use of plastic materials for casing in water wells. A subject only alluded to in the 1968 edition, the use of plastic well casing and screen has had phenomenal growth in the United States. So much was the usage increased that a national materials standard has been developed and a manual of installation practices has just been published.

2. The use of the air rotary drilling method for constructing wells in the hard rock areas of the State. Although this method of drilling was in use in 1968, its use has mushroomed since then. The equipment is very effective and very fast. Coupled with the use of plastic well casing, the method has made the construction of a well several hundred feet deep in one day a common event in hard rock areas.

3. Rapid growth in the use of well screens in place of perforated casing in the intake sections of wells.

4. Increased use of the reverse-circulation method of well drilling for large diameter deep wells in unconsolidated formations. It too is an extremely fast method.

[1] One other report, Bulletin 74-1, "Cathodic Protection Well Standards: State of California", March 1973 deals with another kind of well. Cathodic protection wells house devices used to alleviate electrolytic corrosion of pipelines, tanks, and similar installations. Such wells may also function as instruments for the deterioration of ground water quality. For that reason, standards for their construction and destruction have also been issued.
Other factors include:

1. Population growth in the hilly and mountainous rural areas of California, which has resulted in a heavy demand for individual and community water supplies in those areas.

2. The 1976-77 drought, the most severe in a half-century, which caused a heavy demand for new wells, replacement wells, and well deepenings. It also produced an increased awareness of the significance of the State's ground water resources.

3. The increasing cost of energy for pumping. In terms of well construction and operation, this has meant greater interest in the design of efficient wells and in well maintenance (previously, a much neglected activity).

These as well as other considerations led to the decision to revise the 1968 edition.

This edition is composed of this chapter, Chapter II, "Standards", and five appendixes.

While there have been a number of modifications and additions to them, the 25 sections of Chapter II, "Standards", are as listed in the 1968 edition. All references to existing laws, standards, and publications have been updated and, where appropriate, additional explanation is provided. Every effort has been made to clarify wording to ensure its understanding. A number of figures illustrating the standards have been included.

Many technical terms concerning ground water and water well construction are frequently misunderstood or misinterpreted. The term "seal" or "sealing", for example, has several meanings in the jargon of the well driller, geologist, and engineer, depending on what part of the well installation is under discussion. In this report, we have tried to ensure that the technical terms used are understandable.

A list of definitions appears in Appendix A. Certain definitions are made a part of the standards and are presented in Chapter II. Appendixes B, C, and D describe sealing methods, disinfection, and water quality sampling respectively.

Numerous publications relating to the construction of water wells and to the development, use, and protection of ground waters have been reviewed in preparation of this report. Included is a considerable body of literature on well construction that has been written since 1968. They are listed in Appendix E in alphabetical order by author.

Establishing and Enforcing Standards

Authority for establishing and enforcing standards for construction and destruction of water wells has always rested with the 58 counties and 429 cities in California.
<table>
<thead>
<tr>
<th>County</th>
<th>Ordinance Number</th>
<th>Date Adopted</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda</td>
<td>73-68</td>
<td>7/17/73</td>
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<tr>
<td>Butte</td>
<td>1845</td>
<td>8/2/77</td>
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<td>11/12/73</td>
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<tr>
<td>Fresno</td>
<td>470-A-39</td>
<td>10/22/74</td>
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<td>897</td>
<td>12/21/72</td>
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<tr>
<td>Inyo</td>
<td>309</td>
<td>10/4/76</td>
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<tr>
<td>Kings</td>
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<td>1/13/76</td>
<td></td>
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<tr>
<td>Los Angeles</td>
<td>10075</td>
<td>9/1/70</td>
<td></td>
</tr>
<tr>
<td>Madera</td>
<td>412</td>
<td>3/16/76</td>
<td></td>
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<tr>
<td>Mariposa</td>
<td>373</td>
<td>9/18/73</td>
<td></td>
</tr>
<tr>
<td>Mendocino</td>
<td>1135</td>
<td>8/28/73</td>
<td></td>
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<tr>
<td>Merced</td>
<td>752</td>
<td>6/10/75</td>
<td></td>
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<tr>
<td>Mono</td>
<td>75-459</td>
<td>8/26/75</td>
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<tr>
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<td>1967</td>
<td>5/29/73</td>
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<tr>
<td>Napa</td>
<td>335</td>
<td>12/1/70</td>
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<tr>
<td>Orange</td>
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<td>7/18/72</td>
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<tr>
<td>Sacramento</td>
<td>508</td>
<td>10/26/55</td>
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<tr>
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<td>1954</td>
<td>10/15/74</td>
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<td>San Diego</td>
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<td>San Mateo 1/</td>
<td>2413</td>
<td>1/11/77</td>
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<tr>
<td>Santa Barbara</td>
<td>2769</td>
<td>9/29/75</td>
<td></td>
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</tbody>
</table>
| Santa Clara 2/  | 75-6             | 10/14/75     | Ordinance of the Santa Clara Valley Water Dist.
| Santa Cruz      | 1577             | 2/16/71      |                                              |
| Shasta          | 479              | 6/30/69      |                                              |
| Sonoma          | 1594             | 12/18/72     |                                              |
| Stanislaus      | NS443            | 6/5/73       |                                              |
| Tulare          | 1758             | 8/13/74      | Amended 4/16/76                             |
| Ventura         | 2372             | 8/31/70      | Amended 10/1/79                             |
| Yolo            | 765              | 9/7/76       |                                              |

1/ Predecessor ordinance numbers 1100 (12/15/55) and 2324 (7/8/75).
2/ Separate ordinance for subdivision wells - NS1203.22 (4/21/64).
The amount of water needed is determined by the intended use of the water. For example, on the average, each person in a household uses 100 gallons (380 litres) of water a day. To the daily household use must be added seasonal uses such as lawn and garden irrigation, swimming pools, etc. Table 4 lists the volume of water supplied from a small capacity well, assuming continuous pumping for 24 hours. Thus, a well supplying one to three gallons (4 to 11 litres) per minute is a reasonable amount for a single family dwelling. Additional amounts, such as for watering livestock or irrigating small acreages of crops, must be added to these values. Table 4 also indicates that a family of four could subsist on the water supplied by a well pumping constantly at the rate of only one-quarter gallon (0.95 litre) per minute. Unfortunately, at this rate there is little margin for error.

Small Capacity Wells. Performance tests for small capacity wells are relatively simple. A widely used test for small capacity wells is a pump test which lasts for four hours or until an apparently stable pumping level has been achieved at a rate equal to that expected for the permanent pump. However, in the hilly and mountainous "hard rock" areas of the State there are no defined aquifers and supplies are related to fracture patterns, the nature and extent of the soil mantle, faults, changes in stratigraphy, etc. In such areas the production potential of a well cannot be accurately assessed. Further, wells in these areas often exhibit a satisfactory initial production, which then declines due to poor recharge characteristics of the surrounding material. In such situations a longer than usual test, upwards of 12 to 24 hours (and longer) duration, may be desirable.

Bailing or air-blow tests give an approximate indication of production. They do not provide information of the accuracy needed to determine well capacity or to design an efficient pump system. (Air lift testing differs from air-blow testing. It involves pumping with air, not blowing the water out of the well as is the case with the air-blow test.)

The ability of the water level in a small capacity well to recover should be observed. If the water level fails to return to nearly its original level after 24-hours, the reliability of the producing zone is open to question.

Large Capacity Wells. Where large capacity wells are concerned, capacity tests are more elaborate and extensive. Such wells are usually located in defined, productive ground water basins, where considerable information on existing conditions is normally available to aid in the evaluation of their performance. All should be pump tested; bailer tests are of little value. The test pump should be capable of pumping 125 percent of the desired yield of the well. Pumping should be continued at a uniform rate until the "cone of depression" reflects any boundary condition that could affect the performance of the well. This could be as short as six hours and as long as several days, depending on aquifer characteristics and knowledge.
maintenance and operating costs over the long run, although it should be recognized that there is a limit to what can be achieved when compared to expenditure. Current design and construction technology is capable of producing wells with efficiencies of 80 to 90 percent. Pumping-plant or "wire-to-water" efficiency is currently at 65-70 percent.

Sanding

Irrespective of size or composition, any loose material entering a well is usually called "sand", and wells that regularly produce significant quantities of loose material are termed "scammers". The continued influx of sand to a well results in damage to pumps and leads eventually to decreased capacity, and thus a reduction in well efficiency. Further, enough sand may pass through the well to create cavities in the aquifer around the intake section of the well. As a result, such cavities can collapse and damage the well casing or screen. While most wells pump a minor amount of sand, excessive sanding is usually caused by poor well design or inadequate development.

Uncased ("Open-bottom") Wells. Casing serves to hold up the walls of the borehole and provide a path for the movement of the water. In formations with material that will not loosen and be carried away by the inflowing water, such as crystalline rock and other "hard rock" formations, the practice is to leave the intake sections uncased. (Theoretically in such instances, well efficiency would be 100 percent.) Unfortunately, in certain areas some drillers, believing the underlying material to be fully consolidated or attempting to save on costs, have drilled open-bottom wells that later produced sand. Furthermore, as pumps lowered following declining water levels, such wells developed sanding problems. This occurred in several areas in the Central Valley during the 1976-77 drought. In such instances, the wells should have been completely cased to prevent caving and the intake section screened to prevent the entrance of sand.

Inadequately Designed Intake Sections. Sanding is often the result of poor selection of screen size or perforation dimensions and/or, where used, filter material (the "gravel pack"). The well screen aperture (slot) openings or the perforation size, together with the length of screen or perforated section, should be selected to provide sufficient open area to allow the desired quantity of water to enter with minimal friction losses while keeping out 90 to 95 percent of the natural aquifer material or filter material.

Artificial filter materials perform a similar function. In addition to allowing the water to enter the well openings and preventing the entrance of fine-grained material, artificial filters are also used to increase the effective diameter of the well and increase the yield of certain wells by allowing numerous thin aquifers to produce water. On the other hand they need not be used unless there are conditions that make their use desirable or necessary.
Water Well Drillers' Reports

Detailed and comprehensive knowledge of the occurrence and quality of California's ground water resources is vital to protecting, conserving, and properly developing them. The data obtained during the construction of water wells are primary sources of geologic and hydrologic information. In 1949 the Legislature concluded that such information would be invaluable in the event of underground pollution, and would provide a fund of geologic information regarding the State's ground water resources. As a result, legislation was passed requiring the filing of a report with the Department. The report is called the Water Well Drillers' Report and its submittal is also a requirement of these standards (see Chapter II, Section 9 "Reports"). Additional information about the report is presented in "Guide to the Preparation of the Water Well Drillers' Report", Department of Water Resources, October 1977.

Comments and Public Hearings on Draft Edition

Where a publication is of general interest or its subject is one on which there can be a diversity of opinion, it is the policy of the Department of Water Resources to issue it in preliminary form and solicit comments from interested organizations and individuals and the general public. Since the standards for the construction of wells and the destruction of abandoned wells recommended herein are for application throughout the State, and because they are specified by many counties and cities (in ordinances or regulations), a draft edition was prepared and distributed for comment (April 14, 1981). In addition, four public hearings or meetings (of an informal nature) were held to obtain the views of persons interested in, or concerned with, the construction and use of water wells. These hearings were conducted in cooperation with the Department of Health Services represented by its Sanitary Engineering Section since this report contains provisions which pertain to the public health aspects of water well construction. The hearings were held during June 1981 at Berkeley, Fresno, Redding and Los Angeles. In response to a number of requests, the comment period was extended to September 1981.

Fifty-five persons representing 33 individuals and organizations attended the four hearings. Five formal (written) statements were presented and 16 persons commented verbally. In addition, written comments were received from 33 other organizations and individuals. Those submitting written comments are listed in Table 5. Copies of the written comments are available for inspection in the Department's file in Sacramento.

All comments were carefully reviewed and considered. As might be expected, opinions differed on the applicability of certain standards, guidelines, and procedures. There is, of course, some validity in each point-of-view, which forms the basis for reconsideration. Many comments were incorporated in this final draft. Others were not used for various reasons. Most of the comments dealt mainly with (1) the
<table>
<thead>
<tr>
<th>Organization</th>
<th>Representative</th>
<th>Date of Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern California Water Co.</td>
<td>D. F. Kostas</td>
<td>8/20/81</td>
</tr>
<tr>
<td>Stanislaus Co. Department of Environmental Resources</td>
<td>J. Aud</td>
<td>6/25/81</td>
</tr>
<tr>
<td>State Water Resources Control Board</td>
<td>C. Whitney</td>
<td>6/16/81</td>
</tr>
<tr>
<td>Joseph B. Summers, Civil Engineer, Inc.</td>
<td>J. B. Summers</td>
<td>6/5/81</td>
</tr>
<tr>
<td>Joseph B. Summers, Civil Engineer, Inc.</td>
<td>R. L. Reynolds</td>
<td>8/28/81</td>
</tr>
<tr>
<td>Tulare Lake Basin Water Storage District</td>
<td>B. L. Graham</td>
<td>6/5/81</td>
</tr>
<tr>
<td>Ventura Co. Environmental Health Department</td>
<td>D. W. Koepp</td>
<td>6/8/81</td>
</tr>
<tr>
<td>Ventura Co. Public Works Agency</td>
<td>G. J. Nowak</td>
<td>8/14/81</td>
</tr>
<tr>
<td>Water Well Surveys</td>
<td>W. C. Wigley</td>
<td>6/16/81</td>
</tr>
<tr>
<td>Well Products West, Inc.</td>
<td>C. Willis</td>
<td>6/12/81</td>
</tr>
<tr>
<td>Woodward-Clyde Consultants</td>
<td>J. A. Gilman</td>
<td>6/24/81</td>
</tr>
</tbody>
</table>

standards in Chapter II (following) more specifically, sections 1, 8, 9, 10, 11, 12, 13, 21 and 23; (2) the Design and Performance Guidelines section of this chapter; and (3) Appendixes B, C and D, which deal with methods and procedures.
CHAPTER II. STANDARDS

The standards presented in this chapter are intended to apply to the construction (including major reconstruction) or destruction of water wells throughout the State of California. However, under certain circumstances, adequate protection of ground water quality may require more stringent standards than those presented here; under other circumstances, it may be necessary to substitute other measures which will provide protection equal to that provided by these standards. Such situations arise from practicalities in applying any standards or, in this case, from anomalies in ground water geology or hydrology. Since it is impractical to prepare standards for every conceivable situation, provision has been made for deviation from the standards as well as for additional ones. However, the Department believes that for most conditions encountered in the State, the standards presented in this report are satisfactory for the protection of ground water quality.

In the past, the Department expended considerable effort in defining areas where standards should be applied to prevent the mixing of waters of differing qualities in specific ground water areas in California. For example, ground waters of varying quality in the San Joaquin Valley are naturally separated by a confining bed commonly called the "Corcoran Clay". The standards presented in this chapter continue to support the findings and recommendations made regarding the application of standards to the specific areas previously studied. (See Table 1, Chapter I.)

Part I. General

Section 1. Definitions.

A. Well or Water Well. As defined in Section 1371 of the Water Code, well or water well:

"...means any artificial excavation constructed by any method for the purpose of extracting water from, or injecting water into, the underground. This definition shall not include: (a) oil and gas wells, or geothermal wells constructed under the jurisdiction of the Department of Conservation, except those wells converted to use as water wells; or (b) wells used for the purpose of (1) dewatering excavations during construction, or (2) stabilizing hillsides or earth embankments."

B. Community Water Supply Well. A water well used to supply water for domestic purposes in systems subject to Chapter 7, Part 1, Division 5 of the California Health and Safety Code. Included are wells supplying public water systems classified by the Department of Health Services as

1/ Technical terms are defined in Appendix A.
J. Test Wells. Wells constructed for the purpose of obtaining the information needed to design a well prior to its construction. Such wells are not to be confused with "test holes" or "exploration holes" which are temporary in nature (i.e., uncased excavations whose purpose is the immediate determination of existing geologic and hydrologic conditions). Test wells are cased and can be converted to observation or monitoring wells and under certain circumstances to production wells.

K. Inactive or Standby Well. A well not routinely operating but capable of being made operable with a minimum of effort.

L. Enforcing Agency. An agency designated by duly authorized local, regional or state government to administer laws or ordinances pertaining to well construction. For community water supply wells the enforcing agency is the State Department of Health Services or the local health department.

Section 2. Application to Type of Well.

Except as prescribed in Sections 3 and 4 (following) these standards shall apply to all types of wells described in Section 1. Before a change of use is made of a well, compliance shall be made with the requirements for the new use as specified herein.1/

Section 3. Exemption Due to Unusual Conditions.

If the enforcing agency finds that compliance with any of the requirements prescribed herein is impractical for a particular location because of unusual conditions or if compliance would result in construction of an unsatisfactory well, the enforcing agency may waive compliance and prescribe alternative requirements which are "equal to" these standards in terms of protection obtained.

Section 4. Exclusions.

The standards prescribed in Part II, "Construction", do not apply to exploration and test holes. However, the provisions of Section 7, "Reports" (following) and Part III, "Well Destruction", do apply to these holes.

Springs are excluded from these standards.2/

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1/ An example would be an agricultural well converted to use as a community water supply well.

2/ Methods which can be used to protect water supplies furnished by springs and infiltration galleries are described in "Manual of Individual Water Supply Systems", U. S. Environmental Protection Agency, Office of Drinking Water (EPA-430/9-74-007).
Most of the factors involved in determining safe distances in a particular area are usually not known. Based on past experience and general knowledge, the following horizontal distances are considered safe where dry upper unconsolidated formations, less permeable than sand, are encountered:

- Sewer, watertight septic tank, or pit privy: 50 feet (15 metres)
- Subsurface sewage leaching field: 100 feet (30 metres)
- Cesspool or seepage pit: 150 feet (45 metres)
- Animal or fowl enclosure: 100 feet (30 metres)

Where in the opinion of the enforcing agency adverse conditions exist, the above distances shall be increased or special means of protection, particularly in the construction of the well, shall be provided.

B. In addition, if possible, the well shall be located up the ground water gradient (upstream) from the specified sources of contamination. By doing so this provides assurance that potential contamination would be moving naturally away from the area of production. However, in an unconfined aquifer consideration shall also be given to the possibility of reversal of gradient near the well due to pumping (see Figure 3), the pumping of nearby wells, or general decline of the water table.

C. The top of the casing shall terminate above grade or above any known conditions of flooding by drainage or runoff from the surrounding land. For community water supply wells this level is defined as above the

---

1/ Because of the many variables involved in the determination of the safe horizontal distance of a well from potential sources of contamination and pollution, no one set of distances will be adequate and reasonable for all conditions. In areas where adverse conditions exist, the distances listed should be increased. Conversely, where especially favorable conditions exist or where special means of protection, particularly in construction of the well are provided, lesser distances may be acceptable if approved by the enforcing agency.

2/ If the well is a radial collector well, these distances apply to the furthest extended points of the well.

3/ When water is pumped from a well a drawdown "cone of depression" is formed in the water surface surrounding the well and ground water in the area of the cone flows toward the well. Similar cones formed by nearby wells can influence the shape of the cone or enlarge the area being drawn upon resulting in a change in direction of flow.
"...floodplain of a 100 year flood..." or above "...any recorded high tide,..." (Section 64417, "Siting Requirements", Title 22 of the California Administrative Code).1/

In addition, the area around the well shall slope away from the well and surface drainage shall be directed away from the well.

D. Where a well is to be near a building, the well shall be far enough from the building so that the well will be accessible for repair, maintenance, etc.

Section 9. Sealing the Upper Annular Space.

The space between the well casing and the wall of the drilled hole (the annular space) shall be effectively sealed to protect it against contamination or pollution by entrance of surface and/or shallow, subsurface waters.2/

A. Minimum depth of seal below ground surface for various uses of wells:

<table>
<thead>
<tr>
<th>Types</th>
<th>Minimum Depth(^3/) of Seal (below ground surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Water Supply Wells</td>
<td>50 feet (15 metres)</td>
</tr>
<tr>
<td>Individual Domestic Wells</td>
<td>20 feet(^4/) (6.1 metres)</td>
</tr>
<tr>
<td>Industrial Wells</td>
<td>50 feet(^4/) (15 metres)</td>
</tr>
<tr>
<td>Agricultural Wells</td>
<td>20 feet(^4/) (6.1 metres)</td>
</tr>
<tr>
<td>Air-Conditioning Wells</td>
<td>20 feet(^4/) (6.1 metres)</td>
</tr>
<tr>
<td>Observation and Monitoring Wells</td>
<td>20 feet(^4/) (6.1 metres)</td>
</tr>
</tbody>
</table>

1/ If compliance with this requirement for community water supply wells is not possible, the enforcing agency should be contacted regarding alternative means for protection.
2/ Annular seals are also installed to provide protection for the casing against corrosion, to assure structural integrity of the casing, and to stabilize the upper formation.
3/ In those cases where it is not possible to meet or, when necessary, increase, the lateral distances from pollution sources described in Section 8 of these standards, an alternative (or special) means of protection for the well is to increase the depth of the seal.
4/ Exceptions are shallow wells where the water to be developed is at a depth less than 20 feet (6 metres). In this instance, the depth of seal may be reduced but in no case less than 10 feet (3 metres) and special precautions taken in locating the well with respect to sources of pollution.
5/ The annular space shall be sealed to a depth of 50 feet (15 metres) from the surface when the well is close to sources of pollution listed in Section 8.
6/ Because they are constructed to measure specific conditions, the annular space in such wells is usually sealed to make the intake section "depth-discrete". Depending on the circumstances, this depth may be very shallow.
Figure 4. SEALING CONDITIONS FOR UPPER ANNULAR SPACE—UNCONSOLIDATED AND SOFT, CONSOLIDATED FORMATIONS
Figure 5. SEALING CONDITIONS FOR UPPER ANNULAR SPACE—HARD ROCK FORMATIONS AND GRAVEL PACKED WELLS
5. Bentonite clay mixtures shall be composed of bentonite clay and clean water thoroughly mixed before placement so that there are no balls, clods, etc.

6. Used drillers' mud or cuttings or chips from drilling the borehole shall not be used as sealing material.

7. The minimum time that must be allowed for materials containing cement to "set" before construction operations on the well may be resumed shall be:
   a. Type I cement - 72 hours
   b. Type III cement - 48 hours
   c. Type V cement - 6 hours

When necessary these times may be reduced by the use of "accelerators", i.e., additives designed specifically to shorten setting time.

8. Where thermoplastic casing is used, caution should be exercised to control the heat generated during the curing of the cement (called "heat of hydration"). This is of special concern where casing of thinner wall thicknesses are to be installed. The addition of bentonite to the cement mixture (up to 8 percent) or circulating water inside the casing will lower the temperature of the cement. Additives which accelerate the curing process also tend to increase the heat generated and should not be used where thermoplastic casing is installed.

E. Thickness of Seal. The thickness of the seal shall be at least a nominal 2 inches,2/ and not less than three times the size of the largest coarse aggregate used in the sealing material.

F. Placement of Seal.

1. Before placing the seal all loose cuttings, drilling mud, or other obstructions shall be removed from the annular space by flushing.

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1/ Clay in the form of a mud-laden fluid is similar to and has the advantages of neat cement and sand-cement grout. There is a disadvantage in that clay may separate from the fluid. Clay should not be used where structural strength or stability of the seal is required, where flowing or moving water might break it down, or where it might dry out. Although there are other types of clay available, none have the sealing properties (particularly the ability to expand dramatically) comparable to bentonite. Therefore, only bentonite clays are recommended.

2/ In other words, the borehole shall be nominally 4 inches (100 millimetres) larger in diameter than the nominal casing diameter (thus creating a 2-inch, or 50 millimetre annular space).
Figure 6. TYPICAL SURFACE CONSTRUCTION FEATURES
2. Where the pump is offset from the well or where a submersible pump is used, the opening between the well casing and any pipes or cables which enter the well shall be closed by a watertight seal or "well cap".

3. If the pump is not installed immediately or if there is a prolonged interruption in construction of the well, a watertight cover shall be installed at the top of the casing.

4. A watertight seal or gasket shall be placed between the pump discharge head and the discharge line; or, in the event of a below-ground discharge, between the discharge pipe and discharge line (see Figures 6 and 7).

5. If a concrete base or slab (sometimes called a pump block or pump pedestal) is constructed around the top of the casing, it shall be free from cracks, honeycombs or other defects likely to detract from its watertightness. The joint between the base and the annular seal must also be watertight. The base shall slope away from the well casing. The minimum thickness of the concrete base shall be 4 inches (100 millimetres).1/

6. Where the well is to be gravel packed and the pack extends to the surface, a watertight cover shall be installed between the conductor casing and the inner casing (see also Section 9, Part B, Item 5 and Figure 5).

B. Well Pits. Because of their susceptibility to contamination and pollution, the use of well pits should be avoided whenever possible. A substitute device called a pitless adapter2/ or pitless adapter unit (a variation) may be used in place of a well pit.

C. Enclosure of Well and Appurtenances. In community water supply wells, the well and pump shall be located in a locked enclosure to exclude access by unauthorized persons.

1/ This value is for small (under 10 inches or 250 millimetre in diameter) individual domestic well installations. The shape and dimensions of pump bases vary with the size, weight, and type of pumping equipment to be installed and the bearing capacity of the soil on which it is situated. A variety of designs have been used. For large diameter turbine pump installations the Vertical Turbine Pump Association has developed a standard design for a square, concrete pump base that is based on weight, including full pump column and soil bearing capacity. (See Bibliography, Appendix E.)

2/ Pitless adaptors and units were developed for use in areas where prolonged freezing occurs and below ground (below frost line) discharges are common. Both the National Sanitation Foundation and Water Systems Council have developed standards for their manufacture and installation (See Bibliography, Appendix E.)
Section 12. Casing.

A. Casing Material. Requirements pertaining to well casing are to insure that the casing will perform the functions for which it is designed, i.e., to maintain the hole by preventing its walls from collapsing, to provide a channel for the conveyance of the water, and to provide a measure of protection for the quality of the water pumped.

1. Well casing shall be strong and tough enough to resist the forces imposed on it during installation and those forces which can normally be expected after installation.

2. Steel is the material most frequently used for well casing, especially in drilled wells. The thickness of steel used for well casing shall be selected in accordance with good design practices applied with due consideration to conditions at the site of the well. There are three principal classifications of steel materials used for water well casing, and all are acceptable for use so long as they meet the following conditions.

1/ Abbreviations used are: API-American Petroleum Institute; ASTM-American Society for Testing and Materials; AWWA-American Water Works Association.

2/ Selection of casing depends on its ability to resist external forces as well as factors affecting the casing serviceability. The maximum theoretical external pressure under which a particular well casing of a specific diameter and thickness will collapse can be calculated. However, other considerations such as the effect of driving the casing into place or other impact forces which may have an effect on the ability of a particular casing to resist external pressures, cannot be calculated with accuracy. Good design practices preclude the selection of a casing of a particular thickness for use where it will experience external pressures approaching the maximum or where unknown forces might magnify the effect of the external forces. Instead it is customary for designers to introduce factors of safety which tend to ensure that the casing selected will resist all probable forces imposed upon it. Consequently, experience and sound judgment, coupled with these factors or safety, have so far proved to be the best guide in selecting the proper casing. Suggested thicknesses for steel casing for various depths and diameters are to be found in material published by the various steel manufacturers and fabricators and in publications on the design of water wells. The suggested thicknesses contained in such publications are not to be considered a part of these standards.
c. High strength carbon steel sheets referred to by their manufacturers and fabricators as "well casing steel". At present, there are no standard specifications concerning this material. However, the major steel producers market products whose chemical and physical properties are quite similar. Each sheet of material shall contain mill markings which will identify the manufacturer and specify that the material is well casing steel which complies with the chemical and physical properties published by the manufacturer.

d. Stainless steel casing shall meet the provisions of ASTM A409, "Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service".

3. Plastic is also used as casing for water wells in many locations under a variety of circumstances. Because large-diameter (10 inches or 250 millimetres and larger) plastic casing has not been used extensively and especially at depths exceeding 300 feet (90 metres), special care must be exercised in the design and construction of wells that will employ these sizes. Particular attention should be given to the effect of thermoplastic casing of heat generated during cementing operations (see also Part B, "Installation of Casing" of this section, item 8, Part D, "Sealing Material" of Section 9, and discussion of plastic casing in Chapter I).

There are two groups of plastic materials available: thermoplastics and thermosts. Thermoplastics soften with the application of heat and reharden when cooled. Thus they can be repeatedly reformed. Thermosts cannot be reformed. During manufacture their molecules are permanently "set" by heat, chemical action or a combination of both. Thermoplastics used for plastic casing are ABS (acrylonitrile butadiene styrene), PVC (polyvinyl chloride) and SR (styrene rubber). The thermostsetting plastic used for casing is fiberglass.

1/ Information about the selection and installation of thermoplastic casing will be found in "Manual on the Selection and Installation of Thermoplastic Water Well Casing", a joint publication of the National Water Well Association and the Plastic Pipe Institute.
(b) ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe".

(c) AWWA C300, "AWWA Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids".

(d) AWWA C301, "AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids".

5. Other materials, except as listed in No. 6 below, may be used as casing for water wells, subject to the approval of the enforcing agency.

6. Galvanized sheet metal pipe ("downspout"), or natural wood shall not be used as casing.

B. Installation of Casing. All casing shall be placed with sufficient care to avoid damage to casing sections and joints. All joints in the casing above the perforations or screens shall be watertight. The uppermost perforations shall be at least below the depth specified in Section 9, Part A, "Depth of Seal". Casing shall be equipped with centering guides to ensure even thickness of annular seal and/or gravel pack.

1. Metallic casing. Steel casing may be joined by either welding or by threading and coupling. Welding shall be accomplished in accordance with standards of American Welding Society or the most recent revision of the American Society of Mechanical Engineers Boiler Construction Code. Where casing is driven, (as is generally the case when the cable tool method of construction is used), the casing shall be equipped with a "drive shoe" at the lower end.

2. Plastic (non-metallic) casing. Depending on the type of material and its fabrication, plastic casing may be joined by solvent welding or mechanically joined (threaded or otherwise coupled). The solvent cement used for solvent welding shall meet the specifications for the type of plastic used and shall be applied in accordance with the manufacturer's instructions, particularly those pertaining to setting time required for the joint to develop handling strength. An adapter shall be used to join plastic casing to metallic casing or screen.

1/ Such as wrought iron, asbestos cement pipe, and synthetic woods, all of which have been successfully employed as casing in California or elsewhere. Their present use is limited to special cases. Specifications for most of these materials are published by either ASTM or AWWA.

2/ Information about the installation of thermoplastic casing will be found in "Manual on the Selection and Installation of Thermoplastic Water Well Casing", a joint publication of the National Water Well Association and the Plastic Pipe Institute.
Figure 8. SEALING-OFF STRATA
Section 16. Special Provisions for Large Diameter Shallow Wells.

A. Use as Community Water Supply Wells. Because shallow ground waters are often of poor quality and because they are easily contaminated, the use of bored or dug wells, or wells less than 50 feet (15 metres) deep, to provide community water supplies shall be avoided (unless there is no other feasible means for obtaining water). When used for this purpose, these wells shall be located at least 250 feet (76 metres) from any underground sewage disposal facility.

B. Bored Wells. All bored wells shall be cased with concrete pipe or steel casing whose joints are watertight from 6 inches (150 millimetres) above the ground surface to the depths specified in Section 9, Part A. Except where corrugated steel pipe is used as casing, the minimum thickness of the surrounding concrete seal shall be 3 inches (75 millimetres). Where corrugated steel pipe is employed, the joints are not watertight and a thicker annular seal (no less than 6 inches or 150 millimetres) shall be installed.

C. Dug Wells. All dug wells shall be "curbed" with a watertight curbing extending from above the ground surface to the depths specified in Section 9, Part A. The curbing shall be of concrete poured-in-place or of casing (either precast concrete pipe or steel) surrounded on the outside by concrete.

If the curbing is to be made of concrete, poured-in-place, it shall not be less than 6 inches (150 millimetres) thick. If precast concrete pipe or steel casing is used as part of the curbing, the space between the wall of the hole and the casing shall be filled with concrete to the depths specified in Section 9, Part A. The minimum thickness of the surrounding concrete shall be 3 inches (75 millimetres).

D. Casing Material. Either steel (including corrugated steel pipe) or concrete may be used for casing bored or dug wells. Corrugated aluminum pipe is not recommended for use as casing.1/

1/ Aluminum placed in an aggressive soil is subject to electrolytic corrosion. When the soil pH is very high (over 8.0) or very low (under 6.0) this could present problems and, therefore, the soil pH ought to be checked. In addition, galvanic corrosion is likely to take place unless the pump is also made of aluminum. Accordingly, the use of most of the aluminum alloys currently available is not recommended.
Section 17. Special Provisions for Driven Wells ("Well Points").

A. If the well is to be used as an individual domestic well, an oversize hole with a diameter at least 3 inches (75 millimetres) greater than the diameter of the pipe shall be constructed to a depth of 6 feet (1.8 meters) and the annular space around the pipe shall be filled with neat cement, cement grout, or bentonite mud.

B. The minimum wall thickness of steel drive pipe shall be not less than 0.140 inches (3.5 millimetres).

C. Well points made of thermoplastic materials should not be driven but jetted or washed into place.

Section 18. Rehabilitation, Repair and Deepening of Wells.

A. Rehabilitation is the treatment of a well by chemical or mechanical means (or both) to recover lost production caused by incrustation or clogging of screens or the formation immediately adjacent to the well. The following methods used for rehabilitating a well when done with care are acceptable: (1) introduction of chemicals designed for this purpose, (2) surging by use of compressed air, (3) backwashing or surging by alternately starting or stopping the pump, (4) jetting with water, (5) sonic cleaning, (6) vibratory explosives, and (7) combinations of these. Methods which produce an explosion (in addition to the use of vibratory explosives mentioned above) are also acceptable provided, however, they are used with great care, particularly where aquifers are separated by distinct barriers to the movement of ground water.

In those cases where chemicals or explosives have been used, the well shall be pumped until all traces of them have been removed.

B. In the repair of wells, material used for casing shall meet the requirements of Section 12 "Casing" of these provisions. In addition, the requirements of Section 11, Part A "Disinfection" and, when applicable, Section 14 "Sealing-off Strata" shall be followed.

C. Where wells are to be deepened, the requirements of Sections 11, 12, 13, 14, and 15 of these standards shall be followed.

Section 19. Temporary Cover.

Whenever there is an interruption in work on the well such as overnight shutdown, during inclement weather, or waiting periods required for the setting up of sealing materials, for tests, for installation of the pump, etc., the well opening shall be closed with a cover to prevent the introduction of undesirable material into the well and to insure the public safety. The cover shall be held in place or "weighted-down" in such a manner that it cannot be removed except with the aid of equipment or through the use of tools.
If the pump has been removed for repair or replacement, the well shall not be considered "abandoned". During the repair period, the well shall be adequately covered to prevent injury to people and to prevent the entrance of undesirable water or foreign matter.

Observation or test wells used in the investigation or management of groundwater basins by governmental agencies or engineering or research organizations are not considered "abandoned" so long as they are maintained for this purpose. However, such wells shall be covered with an appropriate cap, bearing the label, "Observation Well", and the name of the agency or organization, and preferably shall be locked when measurements are not being made. When these wells are no longer used for this purpose or for supplying water, they shall be considered "abandoned".

Section 22. General Requirement.

All "abandoned" wells and exploration or test holes shall be destroyed. The objective of destruction is to restore as nearly as possible those subsurface conditions which existed before the well was constructed taking into account also changes, if any, which have occurred since the time of construction. (For example, an aquifer which may have produced good quality water at one time but which now produces water of inferior quality, such as a coastal aquifer that has been invaded by seawater.)

Destruction of a well shall consist of the complete filling of the well in accordance with the procedures described in Section 23 (following).

Section 23. Requirements for Destroying Wells.

A. Preliminary Work. Before the well is destroyed, it shall be investigated to determine its condition, details of construction, and whether there are obstructions that will interfere with the process of filling and sealing. This may include the use of downhole television and photography for visual inspection of the well.

1. If there are any obstructions, they shall be removed, if possible, by cleaning out the hole.

2. Where necessary, to ensure that sealing material fills not only the well casing but also any annular space or nearby voids within the zone(s) to be sealed, the casing should be perforated or otherwise punctured.

3. In some wells, it may be necessary or desirable to remove a part of the casing. However, in many instances this can be done only as the well is filled. For dug wells, as much of the lining as possible (or safe) should be removed prior to filling.

B. Filling and Sealing Conditions. Following are requirements to be observed when certain conditions are encountered:
Figure 9. PROPERLY DESTROYED WELLS
7. To assure that the well is filled and there has been no jamming or "bridging" of the material, verification shall be made that the volume of material placed in the well installation at least equals the volume of the empty hole.

D. Materials. Requirements for sealing and fill materials are as follows:

1. Impervious Sealing Materials. No material is completely impervious. However, sealing materials shall have such a low permeability that the volume of water passing through them is of small consequence.

Suitable impervious materials include neat cement, sand-cement grout, concrete, and bentonite clay, all of which are described in Section 9, paragraph D, "Sealing Material" of these standards; and well-proportioned mixes of silts, sands, and clays (or cement), and native soils that have a coefficient of permeability of less than 10 feet (3 metres) per year. Used drilling muds are not acceptable.

2. Filler Material. Many materials are suitable for use as a filler in destroying wells. These include clay, silt, sand, gravel, crushed stone, native soils, mixtures of the aforementioned types, and those described in the preceding paragraph. Material containing organic matter shall not be used.

E. Additional Requirements for Wells in Urban Areas.

In incorporated areas or unincorporated areas developed for multiple habitation, to make further use of the well site, the following additional requirements must be met (see Figure 90):

1. A hole shall be excavated around the well casing to a depth of 5 feet (1.5 metres) below the ground surface and the well casing removed to the bottom of the excavation.

2. The sealing material used for the upper portion of the well shall be allowed to spill over into the excavation to form a cap.

3. After the well has been properly filled, including sufficient time for sealing material in the excavation to set, the excavation shall be filled with native soil.

F. Temporary Cover. During periods when no work is being done on the well, such as overnight or while waiting for sealing material to set, the well and surrounding excavation, if any, shall be covered. The cover shall be sufficiently strong and well enough anchored to prevent the introduction of foreign material into the well and to protect the public from a potentially hazardous situation.

1/ Examples of materials of this type are: very fine sand with a large percentage of silt or clay, inorganic silts, mixtures of silt and clay, and clay. Native materials should not be used when the sealing operation involves the use of pressure.
APPENDIX A

DEFINITION OF TERMS
APPENDIX A
DEFINITION OF TERMS

The following terms are defined as used in this report:

Abandoned Well — A well whose use has been permanently discontinued or which is in such a state of disrepair that no water can be produced. Because abandonment is a state that also involves intent on the part of the well owner, a definition that prescribes a set of conditions and a time limit for use in applying standards appears in Section 21 of Chapter II, "Standards", of this report.

Active Well — An operating water well.

Annular Space — The space between two well casings or between the casing and the wall of the drilled hole.

Aquifer — A geologic formation, group of formations or part of a formation that is water bearing and which transmits water in sufficient quantity to supply springs and pumping wells.

Artesian Well — A well which obtains its water from a confined aquifer. The water level in an artesian well stands some distance above the top of the aquifer it taps. Where the pressure is sufficient to force the water level above the surface of the ground, the well is termed a flowing artesian well.

Bailer — A long narrow bucket with a valve in the bottom used to remove cuttings or fluids from a well.

Bentonite — A highly plastic colloidal clay composed largely of montmorillonite used as a drilling fluid additive or as a sealant.

Casing — A tubular retaining structure which is installed in the well bore to maintain the well opening.

Clay — A fine-grained geologic material (grain size less than 0.004 mm in diameter) which has very low permeability.

Conductor Casing — A tubular retaining structure installed in the upper portion of a well between the wall of the drilled hole and the inner well casing.

Cone of Depression — A depression in the water table or piezometric surface of a ground water body that is in the shape of an inverted cone and develops around a well which is being pumped. It defines the area of influence of the pumping well.
Ground Water Basin - A ground water basin consists of an area underlain by permeable materials which are capable of storing or furnishing a significant water supply; the basin includes both the surface area and the permeable materials beneath it.

Grout - A fluid mixture of cement and water of a consistency that can be forced through a pipe and placed as required. Various additives, such as sand, bentonite, and hydrated lime, are used to meet certain requirements. For example, sand is added when a considerable volume of grout is needed.

Impairment - A change in quality of water which makes it less suitable for beneficial use.

Impermeable - That property of a geologic material that renders it incapable of allowing water to move through it perceptibly under the pressure differences ordinarily found in subsurface water.

Impervious Strata - A geologic unit which will not transmit water in sufficient quantity to furnish an appreciable supply to wells or springs.

Inactive Well - A well not routinely operated but capable of being made an operating well with a minimum of effort.

Packer - A device used to plug or seal a well at a specific point; frequently used as retainers to keep grout in position until it "sets".

Perforations - Openings in a well casing to allow the entrance of ground water into the well. Perforations may be made either before or after installation of the casing.

Permeability - The capacity of a geologic material for transmitting a fluid. The degree of permeability depends upon the size and shape of the openings and the extent of the interconnections.

Pollution - Defined in Section 13050 of the California Water Code:

"(1) 'Pollution' means an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects: (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. 'Pollution' may include 'contamination'."

Pressure Grouting - A method of forcing grout into specific portions of a well, such as the annular space, for sealing purposes.
APPENDIX B

SUGGESTED METHODS FOR SEALING
THE ANNULAR SPACE AND FOR SEALING-OFF STRATA
APPENDIX B

SUGGESTED METHODS FOR SEALING THE ANNULAR SPACE AND FOR SEALING-OFF STRATA

Sealing the Annular Space

The annular space is the space between the well casing and wall of the drilled hole created during construction. This space must be adequately sealed to prevent the entrance of surface drainage or poor quality subsurface water, which may contaminate or pollute the well. This seal will also protect the casing against corrosion and possible structural failure.

A number of acceptable sealing methods are presented in this appendix. Other methods may be suggested by individual well drillers on the basis of their experience and availability of equipment. An acceptable method should provide for the complete filling of the sealing interval with the appropriate sealing material to the specified depth.

General

Prior to sealing, the annular space should be flushed to remove any loose formation material or drilling mud that might obstruct the operation. The use of centralizers -- devices which are affixed to the casing at regular intervals to prevent it from touching the walls of the hole, thereby keeping the casing centered in the borehole -- are recommended. This assures that the seal is not less than the desired minimum thickness. It is particularly significant for large diameter wells where the casing exceeds 10 inches (250 millimetres) in diameter.

The use of a tremie or grout pipe for the introduction of the sealing material into the annular space is preferred. Where a tremie or grout pipe is used, the minimum annular space should be 2 inches (50 millimetres) and the minimum tremie size should be a nominal 1-1/2 inches (38 millimetres) in diameter.

Gravity installation without a grout pipe or tremie should not be attempted when the sealing interval contains water or cannot be visually inspected (with the aid of a mirror or light). Where sealing material is to be introduced under water or the interval cannot be observed from the surface, methods involving "positive" placement (by a tremie or grout pipe, pumping or other application of pressure) must be used.

The sealing material must always be introduced at the bottom of the interval to be sealed. This prevents "bridging" (jamming) or segregation (separation of large aggregate from the mixture in sand-cement or concrete grouts) of the sealing material and eliminates gaps.
Figure 10. METHODS FOR SEALING THE ANNULAR SPACE
Figure 11. METHODS FOR SEALING-OFF STRATA
APPENDIX C

SUGGESTED PROCEDURES FOR DISINFECTING WELLS
APPENDIX C

SUGGESTED PROCEDURES FOR DISINFECTING WELLS

Disinfection of all wells is recommended to eliminate pathogenic organisms as well as organisms that can lower the quality of water produced. Disinfection of the well is the last act of well construction or repair before it is placed into service. Wells should also be disinfected following repair or replacement of the pump and/or well maintenance.

Procedures described in this appendix are recommended for existing wells; however, other methods may be used. It can be demonstrated that they will yield similar results. For new wells, disinfection should take place during development (this will assure that the well casing, if drilled, will be protected from drilling mud, dirt, and other debris that reduces effectiveness of the disinfection), testing for yield, installation of the pump. When there is a delay in pump installation, interim or partial disinfection should be taken.

Disinfection involves seven steps:

1. A chlorine solution containing at least 1 mg/l (or parts per million) available chlorine, is added to the well. Table 6 lists quantities of various chlorine contents required to dose 100 feet (30 metres) of water-cased wells ranging from 2 to 24 in. (50 to 600 millimetres). For wells that have been red or when the pump has been repaired or replaced and the well back into service quickly is desired, the solution should contain at least 100 mg/l available chlorine. Maintain this concentration, double the amounts shown in Table 6.

2. The pump column or drop pipe shall be bored with the chlorine solution as it is lowered into the well.

3. After it has been placed into position, the well shall be turned on and off several times (i.e., "surged") to thoroughly mix the disinfectant with the water in the well. Pump until the water discharged has the odor of chlorine. Repeat this procedure several times at one-hour intervals.

4. The well shall be allowed to stand without pumping for 24 hours.
APPENDIX D
COLLECTION OF WATER QUALITY SAMPLES
APPENDIX E

BIBLIOGRAPHY
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California Well Standards

Water wells - Monitoring wells - Cathodic protection wells

Bulletin 74-90
(Supplement to Bulletin 74-81)

California Department of Water Resources
June 1991
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Notice

This Bulletin is temporarily considered to be a draft. The California Department of Water Resources plans to adopt this Bulletin as final after a public review and comment period. The Department will announce in the future when this Bulletin is final. The Department will also announce any changes to this Bulletin. Announcement will be made through the Department's well standards mailing list.

This page should be removed from this Bulletin when it is announced that the Bulletin has been approved as final.
California Well Standards

Water wells  •  Monitoring wells  •  Cathodic protection wells

Bulletin 74-90
(Supplement to Bulletin 74-81)

David N. Kennedy
Director
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Douglas P. Wheeler
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FOREWORD

During an average year about forty percent of California's water supply comes from ground water. Ground water is used for agricultural, industrial, domestic, and municipal water supplies. Protecting the quality of California's ground water is essential to California's future.

Improperly constructed wells can allow pollution of ground water to the point that the water is either unusable or it requires expensive treatment. The California Water Code requires the Department of Water Resources (DWR) to develop minimum standards for water wells, monitoring wells, and cathodic protection wells to protect ground water quality.

This bulletin is a supplement to DWR Bulletin 74-81, Water Well Standards: State of California, December 1981. Standards in Bulletin 74-81 and this bulletin are minimum requirements for construction, alteration, maintenance, and destruction of water wells, monitoring wells, and cathodic protection wells in California.

This bulletin was prepared in cooperation with the State Water Resources Control Board. The Board adopted a model water well, monitoring well, and cathodic protection well ordinance that implements DWR well standards. All California cities and counties, and some water agencies are required to enact local well ordinances that meet or exceed DWR standards, or they must enforce the Board's model ordinance as if it were their own.

Sometimes well standards adopted by local agencies must be more stringent than DWR's statewide standards because of local conditions. Local agencies play a critical role in protecting ground water quality.

Continued cooperation is needed between the public, industry, local agencies, and the State to ensure that these well standards remain adequate and are put into practice. California's water supply future depends on this cooperation.

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The CALIFORNIA WATER COMMISSION serves as a policy advisory body to the Director of the Department of Water Resources on all California water resource matters. The nine-member citizen commission provides a water resources forum for the people of the State, acts as liaison between the legislative and executive branches of State government, and coordinates federal, State, and local water resources efforts.
## CALIFORNIA WELL STANDARDS

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ACKNOWLEDGEMENTS

This bulletin was prepared after consideration of comments and suggestions from public agencies and private parties. State agencies that provided input include:

- State Water Resources Control Board,
- Regional Water Quality Control Boards,
- Department of Health Services, and,
- California Integrated Waste Management Board.

Many comments and suggestions were received from California cities, counties, and water agencies. Private parties that provided input include the California Groundwater Association, individual well contractors, well construction material and equipment suppliers, and consultants. The Department of Water Resources thanks all persons that provided comments during the preparation of this bulletin.
GENERAL INTRODUCTION

Improperly constructed, altered, maintained, or destroyed wells are a potential pathway for introducing poor quality water, pollutants, and contaminants to good-quality ground water. The potential for ground water quality degradation increases as the number of wells and borings in an area increases.

Improperly constructed, altered, maintained, or destroyed wells can facilitate ground water quality degradation by allowing:

- Pollutants, contaminants, and water to enter a well bore or casing;
- Poor quality surface and subsurface water, pollutants, and contaminants to move between the casing and borehole wall;
- Poor quality ground water, pollutants, and contaminants to move from one stratum or aquifer to another; and,
- The well bore to be used for illegal waste disposal.

Permanently inactive or "abandoned" wells that have not been properly destroyed pose a serious threat to water quality. They are frequently forgotten and become dilapidated with time, and thus can become conduits for ground water quality degradation. In addition, humans and animals can fall into wells left open at the surface.

History of DWR Standards

The Department of Water Resources has responsibility for developing standards for wells for the protection of water quality under California Water Code Section 231. Water Code Section 231 was enacted in 1949.


The law for establishing and implementing well standards was changed significantly in 1986 by Assembly Bill 3127 and Senate Bill 1817 (now Chapters 1152 and 1373, Statutes of 1986). Assembly Bill 3127 (Water Code Section 13801) requires that:

1. By September 1, 1989, the State Water Resources Control Board adopt a model well ordinance implementing DWR standards.

2. By January 15, 1990, all counties and cities, and water agencies where appropriate, adopt a well ordinance that meets or exceeds DWR well standards.

3. By February 15, 1990, the Board’s model ordinance is to be enforced by any county, city, or water agency failing to adopt a well ordinance.

Senate Bill 1817 amended the Water Code to specifically include monitoring wells. It was previously assumed that monitoring wells were included in the collective term "well" used in the law.
As a first step in carrying out provisions of the amended law, the State Water Resources Control Board contracted with DWR to:

1. Review and update water well standards in Bulletin 74-81;
2. Establish minimum standards for monitoring wells; and,

This Bulletin is a supplement to Bulletin 74-81. It was developed to satisfy the Department's contract with SWRCB, to respond to Department responsibilities under the Water Code, and to keep pace with technical advances during the ten-year period following publication of Bulletin 74-81.

An initial draft of this supplement was published in three sections and was sent to interested organizations and individuals for comment during the Fall of 1988. The Department held public hearings in Los Angeles, November 15, 1988 and in Oakland, November 17, 1988 to discuss the draft supplemental standards and receive public comment.

Several sets of written comments for the draft supplemental standards were received by DWR. Written and verbal comments on the standards were reviewed and appropriate changes were incorporated into Final Draft Bulletin 74-90, California Well Standards; Water Wells, Monitoring Wells, Cathodic Protection Wells; Supplement to Bulletin 74-81, January 1990.

Final Draft Bulletin 74-90 was published in November 1989 and was sent to interested organizations and individuals for comment. Comments were reviewed and appropriate changes were incorporated into this final bulletin.

Additional discussion on the history of DWR well standards is contained in Bulletin 74-81.

Relationship of DWR Well Standards Publications

DWR Bulletins 74-81 and 74-1 provided the Department's standards for water wells and cathodic protection wells just prior to this supplement. DWR standards for monitoring wells were generally the same as for water wells prior to this supplement and were included in Bulletin 74-81. The relationship of the various DWR well standards bulletins is illustrated in Figure 1.

Revised standards for water wells in this supplement replace only portions of the water well standards contained in Bulletin 74-81. This supplement is to be used together with Bulletin 74-81 for a complete description of DWR Water Well Standards.

Monitoring well standards are presented separately in this supplement and are in parallel form to the water well standards. Because many physical similarities exist between water wells and monitoring wells, the water well standards are referred to frequently in the monitoring well standards. Water well and monitoring well standards must be considered together for the construction, alteration, maintenance, and destruction of monitoring wells.

Cathodic protection well standards in this supplement replace those in Bulletin 74-1. Because of similarities between cathodic protection wells and water wells, water wells standards are referred to frequently in the cathodic protection well standards. Cathodic protection well standards and water well standards must be considered together for the construction, alteration, maintenance, and destruction of cathodic protection wells.
Figure 1. YEARS DWR WELL STANDARDS
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*Both bulletins are now required for water well, monitoring well, and cathodic protection well standards.
Organization of This Supplement

Standards in this supplement are presented in three parts:

2. Standards for monitoring wells.
3. Updated standards for cathodic protection wells that were originally published in Bulletin 74-1.

Selected technical terms used in this supplement are listed and defined in Appendix A. A list of references is contained in Appendix B.

Limitations of Standards

Well standards contained in Bulletin 74-81 together with well standards in this supplement (Bulletin 74-90) are recommended minimum statewide standards for the protection of ground water quality. The standards are not necessarily sufficient for local conditions. Local enforcing agencies may need to adopt more stringent standards for local conditions to ensure ground water quality protection.

In some cases, it may be necessary for a local enforcing agency to substitute alternate measures or standards to provide protection equal to that otherwise afforded by DWR standards. Such cases arise from practicalities in applying standards, and from variations in geologic and hydrologic conditions. Because it is impractical to prepare "site-specific" standards covering every conceivable case, provision has been made for deviation from the standards.

Standards in Bulletin 74-81 and this supplement (Bulletin 74-90) do not ensure proper construction or function of any type of well. Proper well design and construction practices require the use of these standards together with accepted industry practices, regulatory requirements, and consideration of site conditions.

It is the ultimate responsibility of the well owner and/or the owner's technical and/or contractor representative(s) to ensure that a well does not constitute a significant pathway for the movement of poor-quality water, pollutants, or contaminants; does not constitute a public nuisance or hazard; and, adequately performs a desired function. The Department accepts no responsibility for improper design, construction, alteration, maintenance, function, or destruction of individual wells.

Applicability

Construction standards presented in this supplement apply to all water wells, monitoring wells, and cathodic protection wells constructed after the date of this supplement. Alteration, maintenance, and destruction standards presented in this supplement apply to all water wells, monitoring wells, cathodic protection wells, and "borings" regardless of their original date of construction. Standards contained in Bulletin 74-81 remain in effect except where modified by this supplement (Bulletin 74-90).
WATER WELLS
REVISIONS TO WATER WELL STANDARDS

INTRODUCTION

Revisions to standards in DWR Bulletin 74-81, Chapter II, are presented in this section. All standards in Bulletin 74-81 that are not revised by this supplement (Bulletin 74-90) remain unchanged and in effect. The organization and numbering system used for the revisions is the same as that in Bulletin 74-81.

Table 1, page 10, below, lists portions of Bulletin 74-81 that are replaced by this supplement (Bulletin 74-90). The user of this supplement should strike-out the replaced sections and paragraphs in the copy of Bulletin 74-81 that is enclosed in the back cover of this supplement.
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<td>Remainder of Section 21, Item 1</td>
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<td>54</td>
<td>Item 1</td>
</tr>
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STANDARDS

Part I. General

Section 1. Definitions.

Definitions A through H, and K (page 23 of Bulletin 74-81) are unchanged. The definition for observation and monitoring wells under Definition I has been deleted and replaced with a definition for "exploration hole." Observation or monitoring wells are now addressed in monitoring well standards in this supplement.

The new definition under Definition I is:

"I. **Exploration Hole (or Boring).** An uncased, temporary excavation whose purpose is the determination of hydrologic conditions at a site."

Definitions J and L have been revised to read as follows:

"J. **Test Wells.** Wells constructed to obtain information needed for design of other wells. Test wells should not be confused with "exploration holes", which are temporary. Test wells are cased and can be converted to other uses such as ground water monitoring and, under certain circumstances, to production wells.

L. **Enforcing Agency.** An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of water wells. The California State Department of Health Services or the local health agency is the enforcing agency for community water supply wells."

Sections 2 through 7 (page 25 of Bulletin 74-81) are unchanged.
Part II. Well Construction

Section 8. Well Location With Respect to Pollutants and Contaminants, and Structures.

Note: The title of Section 8 has been revised.

Section 8 (page 26 of Bulletin 74-81) has been revised to read as follows:

**A. Separation.** All water wells shall be located an adequate horizontal distance from known or potential sources of pollution and contamination. Such sources include, but are not limited to:

- sanitary, industrial, and storm sewers;
- septic tanks and leachfields;
- sewage and industrial waste ponds;
- barnyard and stable areas;
- feedlots;
- solid waste disposal sites;
- above and below ground tanks and pipelines for storage and conveyance of petroleum products or other chemicals; and,
- storage and preparation areas for pesticides, fertilizers, and other chemicals.

Consideration should also be given to adequate separation from sites or areas with known or suspected soil or water pollution or contamination.

The following horizontal separation distances are generally considered adequate where a significant layer of unsaturated, unconsolidated sediment less permeable than sand is encountered between ground surface and ground water. These distances are based on present knowledge and past experience. Local conditions may require greater separation distances to ensure ground water quality protection.

<table>
<thead>
<tr>
<th>Potential Pollution or Contamination Source</th>
<th>Minimum Horizontal Separation Distance Between Well and Known or Potential Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any sewer line (sanitary, industrial, or storm; main or lateral)</td>
<td>50 feet</td>
</tr>
<tr>
<td>Watertight septic tank or subsurface sewage leaching field</td>
<td>100 feet</td>
</tr>
<tr>
<td>Cesspool or seepage pit</td>
<td>150 feet</td>
</tr>
<tr>
<td>Animal or fowl enclosure</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

If the well is a radial collector well, minimum separation distances shall apply to the furthest extended point of the well.
Many variables are involved in determining the "safe" separation distance between a well and a potential source of pollution or contamination. No set separation distance is adequate and reasonable for all conditions. Determination of the safe separation distance for individual wells requires detailed evaluation of existing and future site conditions.

Where, in the opinion of the enforcing agency adverse conditions exist, the above separation distances shall be increased, or special means of protection, particularly in the construction of the well, shall be provided, such as increasing the length of the annular seal.

Lesser distances than those listed above may be acceptable where physical conditions preclude compliance with the specified minimum separation distances and where special means of protection are provided. Lesser separation distances must be approved by the enforcing agency on a case-by-case basis.

B. Gradients. Where possible, a well shall be located up the ground water gradient from potential sources of pollution or contamination. Locating wells up gradient from pollutant and contaminant sources can provide an extra measure of protection for a well. However, consideration should be given that the gradient near a well can be reversed by pumping, as shown in Figure 3 (page 28 of Bulletin 74-81), or by other influences.

C. Flooding and Drainage. If possible, a well should be located outside areas of flooding. The top of the well casing shall terminate above grade and above known levels of flooding caused by drainage or runoff from surrounding land. For community water supply wells, this level is defined as the:

"...floodplain of a 100 year flood..." or above "...any recorded high tide...".
(Section 64417, Siting Requirements, Title 22 of the California Code of Regulations.)

If compliance with the casing height requirement for community water supply wells and other water wells is not practical, the enforcing agency shall require alternate means of protection.

Surface drainage from areas near the well shall be directed away from the well. If necessary, the area around the well shall be built up so that drainage moves away from the well.

D. Accessibility. All wells shall be located an adequate distance from buildings and other structures to allow access for well modification, maintenance, repair, and destruction, unless otherwise approved by the enforcing agency.

Section 9. Sealing the Upper Annular Space.

Note: Sealing requirements are also described in Appendix B, page 67 of Bulletin 74-81.

Section 9 (page 29 of Bulletin 74-81) has been revised to read as follows:

"The space between the well casing and the wall of the drilled hole, often referred to as the annular space, shall be effectively sealed to prevent it from being a preferential pathway for movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of an annular seal are to protect casing against corrosion or degradation, ensure the structural integrity of the casing, and stabilize the borehole wall.
A. Minimum Depth of Annular Surface Seal. The annular surface seal for various types of water wells shall extend from ground surface to the following minimum depths:

<table>
<thead>
<tr>
<th>Well Type</th>
<th>Minimum Depth Seal Must Extend Below Ground Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Water Supply</td>
<td>50 feet</td>
</tr>
<tr>
<td>Industrial</td>
<td>50 feet</td>
</tr>
<tr>
<td>Individual Domestic</td>
<td>20 feet</td>
</tr>
<tr>
<td>Agricultural</td>
<td>20 feet</td>
</tr>
<tr>
<td>Air-Conditioning</td>
<td>20 feet</td>
</tr>
<tr>
<td>All Other Types</td>
<td>20 feet</td>
</tr>
</tbody>
</table>

1. Shallow ground water. Exceptions to minimum seal depths can be made for shallow wells at the approval of the enforcing agency, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. The annular seal shall be no less than 10 feet in length.

Caution shall be given to locating a well with a 'reduced' annular seal with respect to sources of pollution or contamination. Such precautions include horizontal separation distances greater than those listed in Section 8, page 12, above.

2. Encroachment on known or potential sources of pollution or contamination. When, at the approval of the enforcing agency, a water well is to be located closer to a source of pollution or contamination than allowed by Section 8, page 12, above, the annular space shall be sealed from ground surface to the first impervious stratum, if possible. The annular seal for all such wells shall extend to a minimum depth of 50 feet.

3. Areas of freezing. The top of an annular surface seal may be below ground surface in areas where freezing is likely, but in no case more than 4 feet below ground surface. 'Freezing' areas are those where the mean length of the freeze-free period described by the National Weather Service is less than 100 days. In other words, 'freezing' areas are where temperatures at or below 32 degrees Fahrenheit are likely to occur on any day during a period of 265 or more days each year. In general, these areas include:

- portions of Modoc, Lassen, and Siskiyou Counties;
- portions of the North Lahontan area including the eastern slope of the Sierra Nevada and related valleys north of Mount Whitney and Mono Lake; and,
- the area of Lake Arrowhead in the San Bernardino Mountains.

4. Vaults. At the approval of the enforcing agency, the top of an annular surface seal and well casing can be below ground surface where traffic or other conditions require, if the seal and casing extend to a watertight and structurally sound subsurface vault, or equivalent feature. In no case shall the top of the annular surface seal be more
than 4 feet below ground surface. The vault shall extend from the top of the annular seal to at least ground surface.

The use of subsurface vaults to house the top of water wells below ground surface is rare and is discouraged due to susceptibility to the entrance of surfece water, pollutants, and contaminants. Where appropriate, pitless adapters should be used in place of vaults.

B. Sealing Conditions. The following requirements are to be observed for sealing the annular space.

1. Wells drilled in unconsolidated, caving material. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled and a conductor casing temporarily installed to at least the minimum depth of annular seal specified in Subsection A, page 14, above. Permanent conductor casing may be used if it is installed in accordance with Item 3, page 15, below, and Item 5 (page 32 of Bulletin 74-81) and if it extends at least to the depth specified in Subsection A, above. One purpose of conductor casing is to hold the annular space open during well drilling and during the placement of the well casing and annular seal.

Temporary conductor casing shall be withdrawn as sealing material is placed between the well casing and borehole wall, as shown in Figure 4A (page 31 of Bulletin 74-81). Sealing material shall be placed at least within the interval specified in Subsection A, above. The sealing material shall be kept at a sufficient height above the bottom of the temporary conductor casing as it is withdrawn to prevent caving of the borehole wall.

Temporary conductor casing may be left in place in the borehole after the placement of the annular seal only if it is impossible to remove because of unforeseen conditions and not because of inadequate drilling equipment, or if its removal will seriously jeopardize the integrity of the well and the integrity of subsurface barriers to pollutant or contaminant movement. Temporary conductor casing may be left in place only at the approval of the enforcing agency on a case-by-case basis.

Every effort shall be made to place sealing material between the outside of temporary conductor casing that cannot be removed and the borehole wall to fill any possible gaps or voids between the conductor casing and the borehole wall. At least two inches of sealing material shall be maintained between the conductor casing and well casing. At a minimum, sealing material shall extend through intervals specified in Subsection A, above.

Sealing material can often be placed between temporary conductor casing that cannot be removed and the borehole wall by means of pressure grouting techniques, as described below and in Appendix B (page 67 of Bulletin 74-81). Other means of placing sealing material between the conductor casing and the borehole wall can be used, at the approval of the enforcing agency.

Pressure grouting shall be accomplished by perforating temporary conductor casing that cannot be removed, in place. The perforations are to provide passages for sealing material to pass through the conductor casing to fill any spaces and voids between the casing and borehole wall. Casing perforations shall be a suitable size and density to allow the passage of sealing materials through the casing and the proper distribution.
of sealing material in spaces between the casing and borehole wall. At a minimum, the perforations shall extend through the intervals specified in Subsection A, above, unless otherwise approved by the enforcing agency.

Temporary conductor casing that must be left in place shall be perforated immediately before sealing operations begin to prevent drilling or well construction operations from clogging casing perforations. Once the casing has been adequately perforated, sealing material shall be placed inside the conductor casing and subjected to sufficient pressure to cause the sealing material to pass through the conductor casing perforations and completely fill any spaces or voids between the casing and borehole wall, at least within the intervals specified in Subsection A, above. Sealing material shall consist of neat cement, or bentonite prepared from powdered bentonite and water, unless otherwise approved by the enforcing agency.

Sealing material must also fill the annular space between the conductor casing and the well casing within required sealing intervals.

2. Wells drilled in unconsolidated material with significant clay layers. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, page 14, above, and the annular space between the borehole wall and the well casing filled with sealing material in accordance with Subsection A, above (see Figure 4B, page 31 of Bulletin 74-81). If a significant layer of clay or clay-rich deposits of low permeability is encountered within 5 feet of the minimum seal depth prescribed in Subsection A, above, the annular seal shall be extended at least 5 feet into the clay layer. Thus, the depth of seal could be required to be extended as much as another 10 feet. If the clay layer is less than 5 feet in total thickness, the seal shall extend through its entire thickness.

If caving material is present within the interval specified in Subsection A, a temporary conductor casing shall be installed to hold the borehole open during well drilling and placement of the casing and annular seal, in accordance with the requirements of Item 1, page 15, above. Permanent conductor casing may be used if it is installed in accordance with Item 3, below and Item 5 (page 32 of Bulletin 74-81) and it extends to at least the depth specified in Subsection A, above.

3. Wells drilled in soft consolidated formations (extensive clays, sandstones, etc.). An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, page 14, above. The space between the well casing and the borehole shall be filled with sealing material to at least the depth specified in Subsection A, above, as shown by Figure 4C (page 31 of Bulletin 74-81).

If a permanent conductor casing is to be installed to facilitate the construction of the well, an oversized hole, at least 4 inches greater in diameter than the outside surface of the permanent conductor casing, shall be drilled to the bottom of the conductor casing or to at least the depth specified in Subsection A, above, and the annular space between the conductor casing and the borehole wall filled with sealing material. In some cases, such as in cable tool drilling, it may be necessary to extend permanent conductor casing beyond the depth of the required depth of the annular surface seal in order to maintain the borehole. Sealing material is not required between conductor
casing and the borehole wall other than the depths specified in Subsection A, above, and Section 13, below (page 46 of Bulletin 74-81)."

Items 4 through 7 (page 32 of Bulletin 74-81) are unchanged. Item 8 has been added, as follows:

"8. Wells that penetrate zones containing poor-quality water, pollutants, or contaminants. If geologic units or fill known or suspected to contain poor-quality water, pollutants, or contaminants are penetrated during drilling, and, the possibility exists that poor-quality water, pollutants, or contaminants could move through the borehole during drilling and well construction operations and significantly degrade ground water quality in other units before sealing material can be installed, then precautions shall be taken to seal off or 'isolate' zones containing poor-quality water, pollutants, and contaminants during drilling and well construction operations. Special precautions could include the use of temporary or permanent conductor casing, borehole liners, and specialized drilling equipment. The use of conductor casing is described in Item 1, page 15, above."

Subsection C (page 34 of Bulletin 74-81) is unchanged. Subsections D, E, and F (page 34 of Bulletin 74-81) have been changed to read as follows:

"D. Sealing Material. Sealing material shall consist of neat cement, sand cement, concrete, or bentonite. Cuttings from drilling, or drilling mud, shall not be used for any part of the sealing material.

1. Water. Water used to prepare sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, be free of petroleum and petroleum products, and be free of suspended matter. In some cases water considered nonpotable, with a maximum of 2,000 milligrams per liter chloride and 1,500 mg/l sulfate, can be used for cement-based sealing mixtures. The quality of water to be used for sealing mixtures shall be determined where unknown.


Types of Portland cement available under ASTM C150 for general construction are:

Type I - General purpose. Similar to American Petroleum Institute Class A.

Type II - Moderate resistance to sulfate. Lower heat of hydration than Type I. Similar to API Class B.

Type III - High early strength. Reduced curing time but higher heat of hydration than Type I. Similar to API Class C.

Type IV - Extended setting time. Lower heat of hydration than Types I and III.

Type V - High sulfate resistance.

Special cement setting accelerators and retardants and other additives may be used in some cases. Special field additives for Portland cement mixtures shall meet the requirements of ASTM C494, Standard Specification for Chemical Admixtures for Concrete, and latest revision thereof.
Hydrated lime may be added up to 10 percent of the volume of cement used to make the seal mix more fluid. Bentonite may be added to cement-based mixes, up to 6 percent by weight of cement used, to improve fluid characteristics of the sealing mix and reduce the rate of heat generation during setting.

Dry additives should be mixed with dry cement before adding water to the mixture to ensure proper mixing, uniformity of hydration, and an effective and homogeneous seal. The water demand of additives shall be taken into account when water is added to the mix.

Minimum times required for sealing materials containing Portland cement to set and begin curing before construction operations on a well can be resumed are:

- Types I and II cement - 24 hours
- Type III cement - 12 hours
- Type V cement - 6 hours

Type IV cement is seldom used for annular seals because of its extended setting time.

Allowable setting times may be reduced or lengthened by use of accelerators or retardants specifically designed to modify setting time, at the approval of the enforcing agency.

More time shall be required for cement-based seals to cure to allow greater strength when construction or development operations following the placement of the seal may subject casing and sealing materials to significant stress. Subjecting a well to significant stress before a cement-based sealing material has adequately cured can damage the seal and prevent proper bonding of cement-based sealants to casing(s).

If plastic well casing is used, care shall be exercised to control the heat of hydration generated during the setting and curing of cement in an annular seal. Heat can cause plastic casing to weaken and collapse. Heat generation is a special concern if thin-wall plastic well casing is used, if the well casing will be subject to significant net external pressure before the setting of the seal, and/or if the radial thickness of the annular seal is large. Additives that accelerate cement setting also tend to increase the rate of heat generation during setting and, thus, should be used with caution where plastic casing is employed.

The temperature of a setting cement seal can be lowered by circulating water inside the well casing and/or by adding bentonite to the cement mixture, up to 6 percent by weight of cement used.

Cement-based sealing material shall be constituted as follows:

a. Neat Cement. For Types I or II Portland cement, neat cement shall be mixed at a ratio of one 94-pound sack of Portland cement to 5 to 6 gallons of 'clean' water. Additional water may be required where special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

b. Sand Cement. Sand-cement shall be mixed at a ratio of not more than 188 pounds of sand to one 94-pound sack of Portland cement (2 parts sand to 1 part cement, by weight) and about 7 gallons of clean water, where Type I or Type II Portland cement is used. This is equivalent to a '10.3 sack mix.' Less
water shall be used if less sand than 2 parts sand per one part cement by weight is used. Additional water may be required when special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

c. Concrete. Concrete is often useful for large volume annular seals, such as in large-diameter wells. The proper use of aggregate can decrease the permeability of the annular seal, reduce shrinkage, and reduce the heat of hydration generated by the seal.

Concrete shall consist of Portland cement and aggregate mixed at a ratio of at least six-94 pound sacks of Portland cement per cubic yard of aggregate. A popular concrete mix consists of eight-94 pound sacks of Type I or Type II Portland cement per cubic yard of uniform 3/8-inch aggregate.

In no case shall the size of the aggregate be more than 1/5 the radial thickness of the annular seal. Water shall be added to concrete mixes to attain proper consistency for placement, setting, and curing.

d. Mixing. Cement-based sealing materials shall be mixed thoroughly to provide uniformity and ensure that no 'lumps' exist.

Ratios of the components of cement-based sealing materials can be varied depending on the type of cement and additives used. Variations must be approved by the enforcing agency.

3. Bentonite. Bentonite clay in 'gel' form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture.

Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volume when hydrated. Only bentonite clay is an acceptable clay for annular seals.

Unamended bentonite clay seals should not be used where structural strength of the seal is required, or where it will dry. Bentonite seals may have a tendency to dry, shrink and crack in arid and semi-arid areas of California where subsurface moisture levels can be low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.

Bentonite clay shall not be used as a sealing material if roots from trees and other deep rooted plants might invade and disrupt the seal, and/or damage the well casing. Roots may grow in an interval containing a bentonite seal depending on surrounding soil conditions and vegetation.

Bentonite-based sealing material shall not be used for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material, unless otherwise approved by the enforcing agency. Bentonite clay shall not be used as a sealing material where flowing water might erode it.

Bentonite clay products used for sealing material must be specifically prepared for such use. Used drilling mud and/or cuttings from drilling shall not be used in sealing material.
Bentonite used for annular seals shall be commercially prepared, powdered, granulated, pelletized, or chipped/crushed sodium montmorillonite clay. The largest dimension of pellets or chips shall be less than 1/5 the radial thickness of the annular space into which they are placed.

Bentonite clay mixtures shall be thoroughly mixed with clean water prior to placement. A sufficient amount of water shall be added to bentonite to allow proper hydration. Depending on the bentonite sealing mixture used, 1 gallon of water should be added to about every 2 pounds of bentonite. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Bentonite preparations normally require 1/2 to 1 hour to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.

Dry bentonite pellets or chips may be placed directly into the annular space below water, where a short section of annular space, up to 10 feet in length, is to be sealed. Care shall be taken to prevent bridging during the placement of bentonite seal material.

Radial Thickness of Seal. A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except where temporary conductor casing cannot be removed, as noted in Subsection B, page 15, above. A minimum of two inches of sealing material shall also be maintained between each casing, such as permanent conductor casing, well casing, gravel fill pipes, etc., in a borehole within the interval to be sealed, unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, for casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

Placement of Seal.
1. Obstructions. All loose cuttings, or other obstructions to sealing shall be removed from the annular space before placement of the annular seal.

2. Centralizers. Well casing shall be equipped with centering guides or 'centralizers' to ensure the 2-inch minimum radial thickness of the annular seal is at least maintained. Centralizers need not be used in cases where the well casing is centered in the borehole during well construction by use of removable tools, such as hollow-stem augers.

The spacing of centralizers is normally dictated by the casing materials used, the orientation and straightness of the borehole, and the method used to install the casing.

Centralizers shall be metal, plastic, or other non-degradable material. Wood shall not be used as a centralizer material. Centralizers must be positioned to allow the proper placement of sealing material around casing within the interval to be sealed.

Any metallic component of a centralizer used with metallic casing shall consist of the same material as the casing. Metallic centralizer components shall meet the same metallurgical specifications and standards as the metallic casing to reduce the potential for galvanic corrosion of the casing.
3. **Foundation and Transition Seals.** A packer or similar retaining device, or a small quantity of sealant that is allowed to set, can be placed at the bottom of the interval to be sealed before final sealing operations begin to form a foundation for the seal.

A transition seal, up to 5 feet in length, consisting of bentonite, is sometimes placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grained sand, usually less than 2 feet in length, is sometimes placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-sized forms of bentonite, such as granules and powder, are usually employed for transition seals if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by use of a tremie pipe, or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in dry form or as slurry for use in transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, 1/2 to 1 hour is required for proper hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sounded to ensure that no bridging has occurred during placement.

4. **Timing and Method of Placement.** The annular space shall be sealed as soon as practical after completion of drilling or a stage of drilling. In no case shall the annular space be left unsealed longer than 14 days following the installation of casing.

Sealing material shall be placed in one continuous operation from the bottom of the interval to be sealed, to the top of the interval. Where the seal is more than 100 feet in length, the deepest portion of the seal may be installed first and allowed to set or partially set. The deep initial seal shall be no longer than 10 feet in length. The remainder of the seal shall be placed above the initial segment in one continuous operation.

Sealing material shall be placed by methods (such as the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing material, or separation of sand or aggregate from the sealing material. Annular sealing materials
shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

5. **Ground Water Flow.** Special care shall be used to restrict the flow of ground water into a well boring while placing material, where subsurface pressure causing the flow of water is significant.

6. **Verification.** It shall be verified that the volume of sealing material placed at least equals or exceeds the volume to be sealed.

7. **Pressure.** Pressure required for placement of sealing materials shall be maintained long enough for cement-based sealing materials to properly set."

Section 10. Surface Construction Features.

Subsection A, Item 5; Subsection B; and Subsection F (page 39 of Bulletin 74-81) have been changed. The remainder of Section 10 (page 36 of Bulletin 74-81) is unchanged.

*A. Openings.*

5. **Bases.** A concrete base or pad, sometimes called a pump block or pump pedestal, shall be constructed at ground surface around the top of the well casing and contact the annular seal, unless the top of the casing is below ground surface, as provided by Subsection B, page 23, below.

The base shall be free of cracks, voids, or other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing, must be water tight and must not cause the failure of the annular seal or well casing. Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

The upper surface of the base shall slope away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency. The base shall be a minimum of 4 inches thick.

A minimum base thickness of 4 inches is normally acceptable for small diameter, single-user domestic wells. The base thickness should be increased for larger wells. Shape and design requirements for well pump bases vary with the size, weight, and type of pumping equipment to be installed, engineering properties of the soil on which the base is to be placed, and local environmental conditions. A large variety of base designs have been used. The Vertical Turbine Pump Association has developed a standard base design for large lineshaft turbine pumps. This design consists of a square, concrete pump base whose design is dependent on bearing weight and site soil characteristics.

Where freezing conditions require the use of a pitless adapter, and the well casing and annular seal do not extend above ground surface or into a pit or vault, a concrete base or pad shall be constructed as a permanent location monument for the covered well. The base shall be 3 feet in length on each side and 4 inches in thickness, unless
otherwise approved by the enforcing agency. The base shall have a lift-out section, or equivalent, to allow access to the well. The lift-out shall facilitate inspection and repair of the well.

B. Well Pits or Vaults. The use of well pits, vaults, or equivalent features to house the top of a well casing below ground surface shall be avoided, if possible, because of their susceptibility to the entrance of poor-quality water, contaminants and pollutants. Well pits or vaults can only be used if approval is obtained from the enforcing agency. A substitute device, such as a pitless adapter or pitless adapter unit (a variation), should almost always be used in place of a vault or pit.

Pitless adapters and units were developed for use in areas where prolonged freezing occurs, and below ground (frost line) discharges are common. Both the National Sanitation Foundation and Water Systems Council have developed standards for the manufacture and installation of pitless adapters and units. (See Appendix E, Bibliography, page 83 of Bulletin 74-81.)

If a pit or vault is used it shall be watertight and structurally sound. The vault shall extend from the top of the annular seal to at least ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing, if any, shall not fail or cause the failure of the well casing or annular seal.

Where cement-based annular seal materials are used, the vault shall be set into or contact the annular seal material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault should be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation.

The sealing material surrounding a vault shall extend from the top of the annular seal to ground surface unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be emplaced in a 'continuous pour'. In other words, cement-based sealing material shall be placed between the vault and excavation and contact the cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access. The outside of the lid shall be clearly and permanently labeled 'WATER WELL'. The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at, or above, grade so that drainage is away from the vault. The top of the well casing contained within the vault shall be covered in accordance with requirements under Subsection A, above, (page 36, Bulletin 74-81) so that water, contaminants, and pollutants that may enter the vault will not enter the well casing. The cover shall be provided with a pressure relief or venting device for gases.
F. **Backflow Prevention.** All pump discharge pipes not discharging or open to the atmosphere shall be equipped with an automatic device to prevent backflow and/or back siphonage into a well. Specific backflow prevention measures are required for drinking water supply wells, as prescribed in Title 17, Public Health, California Code of Regulations (Sections 7583-7585 and 7601-7605, effective June 25, 1987). Irrigation well systems, including those used for landscape irrigation, and other well systems that employ, or which have been modified to employ, chemical feeders or injectors shall be equipped with a backflow prevention device(s) approved by the enforcing agency.

Section 12. Casing.

Items 3, 5, and 6 of Subsection A (page 43 of Bulletin 74-81) have been revised. The remainder of Subsection A is unchanged. Subsection B (page 45 of Bulletin 74-81) has been revised. The revisions are as follows:

\"A. Casing Material.\"

3. **Plastic.** Two basic types of plastic are commonly used for plastic well casing: thermoplastics and thermosets. Thermoplastics soften with the application of heat and reharden when cooled. Thermoplastics can be reformed repeatedly using heat and sometimes can unexpectedly deform. Attention should be given to the effect of heat on thermoplastic casing from the setting and curing of cement. Additional discussion on sealing material and heat generation is in Section 9, Subsection D, 'Sealing Material'.

Thermoplastics used for well casing include ABS (acrylonitrile butadiene styrene), PVC (polyvinyl chloride), and SR (styrene rubber). PVC is the most frequently used thermoplastic well casing in California. Styrene rubber is seldom used.

Unlike thermoplastics, thermoset plastics cannot be reformed after heating. The molecules of thermoset plastic are 'set' during manufacturing by heat, chemical action, or a combination of both. The thermoset plastic most commonly used for well casing is fiberglass.

a. **Thermoplastics.** Thermoplastic well casing shall meet the requirements of ASTM F480, Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80, including the latest revision thereof. (Note: A 'dimension ratio' is the ratio of pipe diameter to pipe wall thickness.)

Pipe made in Schedule 40 and 80 wall thicknesses and pipe designated according to certain pressure classifications are listed in ASTM F480, as well as casing specials referencing the following ASTM specifications:

Thermoplastic well casing that may be subject to significant impact stress during or after installation shall meet or exceed the requirements for impact resistance classification set forth in Section 6.5 of ASTM F480. Casing that may be subject to significant impact forces includes, but is not limited to; casing that is installed in large diameter, deep boreholes; and casing through which drilling tools pass following installation of the casing in a borehole.

b. Thermoset Plastics. Thermoset casing material shall meet the following specifications, as applicable, including the latest revisions thereof:


c. Drinking Water Supply. All plastic casing used for drinking water supply wells, including community supply well and individual domestic wells, shall meet the provisions of National Sanitation Foundation Standard No. 14, Plastic Piping Components and Related Materials and any revision thereof. The casing shall be marked or labeled following requirements in NSF Standard No. 14. Standard No. 14 includes the requirements of ASTM F480.

d. Storage, Handling, and Transportation. Plastic casing shall not be stored in direct sunlight or subjected to freezing temperatures for extended periods of time. Plastic casing shall be stored, handled, and transported in a manner that prevents excessive mechanical stress. Casing shall be protected from sagging and bending, severe impacts and loads, and potentially harmful chemicals.

e. Large Diameter Wells. Because large diameter plastic casing has not been used extensively at depths exceeding 500 feet, special care shall be exercised with its use in deep wells.

5. Unacceptable Casing Materials. Galvanized sheet metal pipe such as 'downspout,' tile pipe, or natural wood shall not be used as well casing.

6. Other Materials. Materials in addition to those described above may be used as well casing, subject to enforcing agency approval.

Subsection B (page 45 of Bulletin 74-81) has been revised as follows:

"B. Casing Installation. All well casing shall be assembled and installed with sufficient care to prevent damage to casing sections and joints. All casing joints above intervals of perforations
or screen shall be watertight. Any perforations shall be below the depths specified in Section 9, Subsection A, page 14, above.

Casing shall be equipped with centering guides or 'centralizers' to ensure the even radial thickness of the annular seal and filter pack.

1. **Metallic Casing.** Metallic casing may be joined by welds, threads, or threaded couplings. Welding shall be accomplished in accordance with the standards of the American Welding Society or the most recent revision of the American Society of Mechanical Engineers Boiler Construction Code. Metallic casing shall be equipped with a 'drive shoe' at the lower end if it is driven into place.

2. **Plastic Casing.** Plastic casing may be joined by solvent welding or mechanically joined by threads or other means, depending on the type of material and its fabrication. Solvent cement used for solvent welding shall meet specifications for the type of plastic casing used. Solvent cement shall be applied in accordance with solvent and casing manufacturer instructions. Particular attention shall be given to instructions pertaining to required setting time for joints to develop strength.

The following specifications for solvent cements and joints for PVC casing shall be met, including the latest revisions thereof:


b. **ASTM D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.**

Plastic casing or screen shall not be subjected to excessive stress during installation and shall not be driven into place. Care shall be taken to ensure that plastic casing and joints are not subjected to excessive heat from cement-based sealing material.

A specifically designed adapter shall be used to join plastic casing to metallic casing or screen.

**Section 14. Well Development.**

Section 14 (page 46 of Bulletin 74-81) has been revised as follows:

"Development, redevelopment, or reconditioning of a well shall be performed with care, by methods that will not damage the well structure or destroy natural barriers to the movement of poor quality water, pollutants, and contaminants.

Acceptable well development, redevelopment, or reconditioning methods include:

- Overpumping;
- Surging or swabbing by use of 'plungers';
- Surging with compressed air;
- Backwashing or surging by alternately starting and stopping a pump;
- Jetting with water;"
- Introducing specifically-formulated chemicals into a well; and,
- Combinations of the above.

Hydraulic fracturing (hydrofracturing) is sometimes an acceptable well development and redevelopment method when properly performed. Good quality water shall be used in hydrofracturing. The water shall be disinfected prior to introduction into a well. Material used as 'propping' agents shall be free of pollutants and contaminants, shall be compatible with the use of a well, and shall be thoroughly washed and disinfected prior to placement in a well.

Development, redevelopment, or reconditioning by use of specially designed explosive charges is in some cases, another acceptable development method. Explosives shall be used with special care to prevent damage to the well structure and to any natural barriers to the movement of poor-quality water, pollutants, and contaminants. Explosives shall only be used by properly-trained personnel.

Wells subjected to chemicals or explosives during development, redevelopment, or reconditioning operations shall be thoroughly pumped to remove such agents and residues immediately after the completion of operations. Chemicals, water, and other wastes removed from the well shall be disposed of in accordance with applicable local, State, and federal requirements. The enforcing agency should be contacted regarding the proper disposal of waste.
Part III. Destruction of Wells

Section 21. Definition of "Abandoned" Well.

Section 21 (page 52 of Bulletin 74-81) has been revised as follows:

"A well is considered 'abandoned' or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. In accordance with Section 24400 of the California Health and Safety Code, the well owner shall properly maintain an inactive well as evidence of intention for future use in such a way that the following requirements are met:

(1) The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.

(2) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(3) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

If a pump has been temporarily removed for repair or replacement, the well shall not be considered 'abandoned' if the above conditions are met. The well shall be adequately covered to prevent injury to people and animals and to prevent the entrance of foreign material, surface water, pollutants, or contaminants into the well during the pump repair period.

Section 23. Requirements for Destroying Wells.

Subsection A, Item 1 (page 53 of Bulletin 74-81) and Subsection B, Item 1, (page 54, of Bulletin 74-81) have been changed. The remainder of Section 23 is unchanged.

Subsection A, Item 1 has been revised as follows:

"1. Obstructions. The well shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction are removed for disposal.

The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency.

The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed."
Subsection B, Item 1 has been revised as follows:

"1. Wells situated in unconsolidated material in an unconfined ground water zone. In all cases the upper 20 feet of the well shall be sealed with suitable sealing material and the remainder of the well shall be filled with suitable fill, or sealing material. (See Figure 9A, page 55 of Bulletin 74-81.)"
MONITORING WELL STANDARDS

INTRODUCTION

Ground water monitoring wells are principally used for observing ground water levels and flow conditions, obtaining samples for determining ground water quality, and for evaluating hydraulic properties of water-bearing strata. Monitoring wells are sometimes referred to as "observation wells."

The quality of water intercepted by a monitoring well can range from drinking water to highly polluted water. In contrast, production or "water wells" are usually designed to obtain water from productive zones containing good-quality water.

The screen or perforated section of a monitoring well usually extends only a short length to obtain water from, or to monitor conditions within, an individual water-bearing unit or zone. Water wells are often designed to obtain water from multiple water-bearing strata. Although there are usually differences between the design and function of monitoring wells and water wells, water wells sometimes are used as monitoring wells, and vice versa.

Monitoring wells, along with other types of wells, can provide a pathway for the movement of poor-quality water, pollutants, and contaminants. Because monitoring wells are often purposely located in areas affected by pollutants and contaminants, they pose an especially significant threat to ground water quality if they are not properly constructed, altered, maintained, and destroyed.

The California Legislature amended the California Water Code in 1986 specifically to include requirements for monitoring well standards. Monitoring wells were previously assumed by the Department to be covered by the collective term "well" in the law.

History of Monitoring Wells

Monitoring wells were first used mainly for water level measurement. These wells were often referred to as piezometers in reference to the "piezometric surface" of ground water. In recent years, the term "piezometric surface" is often replaced by "potentiometric surface." However, the term "piezometer" is still sometimes used for monitoring wells installed only for water level measurement.

Many water level monitoring wells constructed in the past were relatively large in diameter in comparison to today's monitoring wells. Wells up to 10-inches in diameter were often constructed to accommodate various means of water level measurement, including floats for mechanically-operated, continuous water level recorders. Many inactive water wells that could accommodate mechanical water level recording equipment were used as monitoring wells.

Modern electronic water level measuring and recording devices now allow for small-diameter water-level monitoring wells. Some continuous water-level measurement devices can be used in wells less than 2-inches in inside diameter.

The use of monitoring wells for ground water sampling for chemical analysis has increased significantly in the past two decades. The following factors have all served to increase the frequency and scope of ground water quality investigations and the number of monitoring wells constructed:
- Advances in analytical and environmental chemistry;
- Increased knowledge of the adverse effects of chemicals on humans;
- Public awareness of ground water pollution;
- The advent of federal ground water quality protection legislation in the 1970s, and,
- Statutes relating to ground water quality enacted by the California Legislature.

Since the 1970s an entire industry has developed around ground water quality monitoring and monitoring well construction. Numerous private firms are involved in providing technical services for the design and implementation of ground water quality investigations. Many firms are involved in the manufacture, distribution, and marketing of materials and equipment used in constructing and operating monitoring wells.

Most monitoring wells constructed today are used to assess:
- The nature and distribution of pollutants and contaminants in ground water;
- The nature and distribution of naturally occurring chemical constituents;
- Subsurface hydrologic conditions; and,
- Hydraulic properties of strata as they relate to pollutant and contaminant movement.

Some monitoring wells are designed to be multipurpose. Monitoring wells can sometimes be used as "extraction" or "injection" wells for mitigation of pollution or contamination.

Although a significant number of monitoring wells constructed today are for detection and assessment of ground water quality impairment, many monitoring wells are constructed for evaluating ground water supply conditions by allowing ground water level measurement and/or aquifer testing. Still others are constructed for observing water levels associated with excavations and irrigated agriculture.

During 1989, approximately 20 percent of all well drilling in California was for monitoring wells, based on well driller's reports received by the Department of Water Resources. Monitoring wells have been constructed in nearly all California counties. The largest concentrations of water quality monitoring wells occur in metropolitan areas of the State. Large numbers of monitoring wells are installed for detection and assessment of leaks from underground storage tanks.

Types of Monitoring Wells

For the purpose of these standards, the term "monitoring well" is limited to wells designed to monitor subsurface water in the saturated zone, existing at or above atmospheric pressure (ground water); rather than water, water vapor, and/or gases contained in the unsaturated or vadose zone. Monitoring devices used for the unsaturated zone differ significantly from those used for the saturated (ground water) zone.

As shown in Figure 2, three basic types of monitoring wells or "installations" are:

- Individual monitoring wells;
- Nested monitoring wells; and,
- Clustered monitoring wells.

Individual monitoring wells consist of a single casing "string" within a borehole, as illustrated in Figures 2 and 3. Individual monitoring wells are installed in unique locations apart from one another. They are the most common type of monitoring well constructed in California.
Figure 2. MONITORING WELL TYPES

(NOTE: Schematic, not to scale)

A. INDIVIDUAL

B. NESTED

C. CLUSTERED

(Separated but close to one another)
Figure 3. CROSS SECTION OF A TYPICAL MONITORING WELL
(NOTE: Schematic, not to scale)

- Protective Casing with Locking Cover
- Concrete Base
- Annular Space (2" Minimum)
- "Transition" Seal
- Filter Pack
- Bottom Plug or Cap
- Screen
- Centralizer(s)
- Casing
- Borehole
- Water Table
- Casing Cap
Nested monitoring wells consist of two or more casing strings within the same borehole. Normally the screened interval of each casing string is designed to obtain water from different aquifers or water-bearing zones. The purpose of a nested monitoring well is much the same as clustered monitoring wells.

Clustered monitoring wells consist of individual monitoring wells situated close together, but not in the same borehole. The wells within a cluster are normally constructed to obtain water from different aquifers or water-bearing zones. Clustered wells are most often used for monitoring ground water conditions at various depths in roughly the same area.

A nested monitoring well can be difficult to construct because of multiple casings within the same borehole. Care is required during construction to ensure water-bearing zones for each casing string are hydraulically isolated from one another and the annular seals are effective. Some regulatory agencies may prohibit the use of nested monitoring wells for certain contamination or pollution investigations. Normally this can be due to uncertainties about whether water-bearing strata can be isolated and whether the annular seals in a nested well are always effective.

Individual casing strings for the various types of monitoring wells discussed above, are sometimes designed to obtain water from more than one aquifer or water-bearing unit. These casing strings usually have multiple intervals of openings or screen. Such well casing strings, often referred to as "multi-level monitoring wells," can sometimes serve as a preferential pathway for the movement of poor quality water, pollutants, and contaminants from one unit to another. Some regulatory agencies prohibit the use of multi-level monitoring wells for certain pollution or contamination investigations out of concern for water quality protection and data quality requirements.

Authority and Responsibilities of Other Agencies

As discussed above, Congress enacted major legislation dealing with ground water quality protection during the 1970s. Regulatory programs initiated by federal legislation, such as the Resources Conservation and Recovery Act (RCRA) and its amendments, are administered by the U. S. Environmental Protection Agency. Some administration and enforcement activities related to federal legislation have been delegated to California State agencies.

The California Legislature enacted legislation expanding efforts for ground water quality protection in California beyond federal requirements. The Legislature assigned several State agencies various responsibilities for investigation, mitigation, and control of ground water pollution and contamination.

The lead enforcement agency for most ground water quality protection issues in California is the State Water Resources Control Board (State Board) and the nine California Regional Water Quality Control Boards (Regional Boards). The State Board oversees the activities of the nine regional boards.

The Department of Health Services or, under some circumstances, the U. S. Environmental Protection Agency, is the lead enforcement agency for ground water quality issues related to hazardous wastes.

The EPA, the Department of Health Services, and the State Board have adopted regulations or standards establishing monitoring requirements for "waste facilities." These regulations or standards include requirements for design and performance of monitoring wells that are often more stringent than standards in this bulletin.

Other State government organizations concerned or directly involved with ground water quality assessment or protection in California include:

- Department of Conservation, Division of Oil and Gas,
- Department of Food and Agriculture,
- Integrated Waste Management Board, and,
- Department of Water Resources.

California cities, counties, and local water agencies are also involved with ground water quality assessment and protection.

The Division of Oil and Gas has authority and responsibility for geothermal wells and other special wells constructed in the State's Geothermal Resources Areas (pursuant to Chapter 4, Division 3, California Public Resources Code). Shallow wells drilled for geothermal observation are subject to regulations and standards established by DOG.

After July 17, 1991 the California Environmental Protection Agency will oversee the activities of the State Water Resources Control Board and the Integrated Waste Management Board. Some of the environmental protection activities of the Department of Health Services and the Department of Food and Agriculture will also come under the California Environmental Protection Agency.

Scope, Organization, and Limitations of Standards

Certain standards that apply to water wells also apply to monitoring wells. Therefore the Monitoring Well Standards refer frequently to the Water Well Standards. Standards that apply only to monitoring wells, or that require emphasis, are discussed in detail in the Monitoring Well Standards. The Monitoring Well Standards are arranged in a format similar to the Water Well Standards.

These standards are not intended as a complete manual for monitoring well construction, alteration, maintenance, and destruction. These standards serve only as minimum statewide guidelines towards ensuring that monitoring wells do not constitute a significant pathway for the movement of poor quality water, pollutants, or contaminants. These standards provide no assurance that a monitoring well will perform a desired function. In most cases ground water monitoring practices and monitoring well performance, or functional requirements, fall under the purview of the various agencies mentioned earlier. Ultimate responsibility for the design and performance of a monitoring well rests with the well owner and/or the owner's contractor, and/or technical representative(s).
STANDARDS

Part I. General

Section 1. Definitions.

A. Monitoring Well. The term "monitoring well" is defined in Section 13712 of the California Water Code as:

"...any artificial excavation by any method for the purpose of monitoring fluctuations in groundwater levels, quality of underground waters, or the concentration of contaminants in underground waters."

B. Exploration Hole (or Boring). An uncased temporary excavation whose purpose is the immediate determination of hydrologic conditions at a site.

C. Enforcing Agency. An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of monitoring wells.

Section 2. Application to Well Type.

These standards apply to all types of monitoring wells, except as prescribed in Sections 3, 4, and 5, below. Before a change in use of a well is made, any standards for the new use must be compiled with.

Section 3. Exemptions for Unusual Conditions.

Under certain circumstances the enforcing agency may waive compliance with these standards and prescribe alternate requirements. These standards may be waived where they are impractical or ineffective because of unusual conditions or would result in an unsatisfactory condition or well function. In waiving any of these standards the enforcing agency shall, if at all possible, require measures be implemented to provide the same or greater level of water-quality protection that would otherwise be provided by these standards.

Section 4. Exclusions.

Most standards in Part II, "Monitoring Well Construction," page 41, do not apply to "exploration holes." However, provisions of Section 7, "Reports," below and Part III, "Destruction of Monitoring Wells," page 50, do apply directly to exploration holes.

Exploration holes for determining suitability of on-site domestic sewage disposal that are less than 10 feet in depth are exempt from the reporting and destruction requirements of these standards.

Large volume excavations for determining the suitability of on-site domestic sewage disposal, such as backhoe trenches, that exceed ten feet in depth are exempt from the requirements of Part III of these standards. However, such excavations shall be backfilled with the excavated material or other suitable fill material and the backfill compacted in lifts to attain at least 90 percent relative compaction in order to restore physical conditions in the excavation as much as possible. If a layer or layers of material that serve to impede the

1 Selected technical terms are defined in Appendix A, page 77.
movement of poor-quality water, pollutants and contaminants are penetrated by the excavation, they shall be reestablished to the degree possible to provide protection for underground waters, unless otherwise approved by the enforcing agency. In some cases it may be necessary to backfill all or a portion of the excavation with sealing material meeting these standards to reestablish natural barriers to the movement of poor-quality water, pollutants, and contaminants.

Section 5. Special Standards.

The enforcing agency may prescribe measures more stringent than standards presented here, where needed to protect public safety or protect water quality.

Section 6. Responsible Parties.

Pursuant to Section 13750.5 (Division 7, Chapter 10, Article 3) of the California Water Code; construction, alteration, and destruction of monitoring wells shall be performed by contractors licensed in accordance with the California Contractors' License Law (Division 3, Chapter 9, California Business and Professions Code), except where exempted by law. Construction, alteration, or destruction of monitoring wells to monitor hazardous waste facilities, other waste facilities, or underground storage tanks, shall be performed under the supervision of a California Registered Professional Engineer, California Registered Geologist, or California Certified Engineering Geologist, where specified by law.

Section 7. Reports.

Monitoring well construction, alteration, and destruction reports shall be completed on forms provided by the California Department of Water Resources. Other types of forms may be used for submission to the Department with the prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant provisions of Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in Guide to the Preparation of the Water Well Drillers Report, Department of Water Resources, October 1977, or its latest revision.
Part II. Monitoring Well Construction

Section 8. Well Location With Respect to Pollutants and Contaminants, and Structures.

Monitoring wells are usually constructed to observe conditions at defined or required locations. Monitoring well locations are usually selected on the basis of known or expected hydrologic, geologic, and water quality conditions and the location of pollutant or contaminant sources. Monitoring wells frequently need to be located close to or within areas of pollution or contamination.

A. Separation. Monitoring wells shall be located an adequate distance from known or potential sources of pollution and contamination, including those listed in Section 8 of the Water Well Standards, unless regulatory or legitimate data requirements necessitate they be located closer.

B. Flooding and Drainage. Monitoring wells should be located in areas protected from flooding, if possible. Provisions for locating monitoring wells in areas of flooding and drainage are contained in Section 8 of the Water Well Standards.

C. Accessibility. All monitoring wells shall be located an adequate distance from buildings and other structures to allow access for well maintenance, modification, repair, and destruction, unless otherwise approved by the enforcing agency.

D. Disposal of Wastes When Drilling in Contaminated or Polluted Areas. Drill cuttings and wastewater from monitoring wells or exploration holes in areas of known or suspected contamination or pollution shall be disposed of in accordance with all applicable federal, State, and local requirements. The enforcing agency should be contacted to determine requirements for the proper disposal of cuttings and wastewater.

Section 9. Sealing the Upper Annular Space.

The space between the monitoring well casing and the wall of the well boring, usually referred to as the "annular space," shall be effectively sealed to prevent it from being a preferential pathway for the movement of poor quality water, pollutants, and contaminants. Since monitoring wells are often constructed to obtain water from discrete intervals, a secondary purpose of the annular seal can be to isolate the well intake section or screen to one water-bearing unit. The annular seal can also serve to protect the structural integrity of the well casing and to protect the casing from chemical attack and corrosion. Because monitoring wells are often located close to, or within areas affected by pollutants and contaminants, an effective annular seal is often critical for the protection of ground water quality.

General discussion of sealing methods and requirements for monitoring wells is contained in Section 9, Section 13, and Appendix B, of the Water Well Standards. Special requirements for monitoring wells include the following:

A. Minimum Depth of Annular Seal.

1. Water quality monitoring wells and monitoring wells constructed in areas of known or suspected pollution or contamination. The annular space shall be sealed from the top of the filter pack or monitoring zone to ground surface, unless otherwise approved by the enforcing agency. The top of the filter pack or monitoring zone shall not extend into another water-bearing unit above the single water-bearing unit being monitored unless otherwise approved by the enforcing agency. The filter pack or monitoring zone shall not extend into any confining layers that overlie or underlie the unit to be moni-
stored, unless otherwise approved by the enforcing agency. The annular surface seal shall be no less than 20 feet in length.

Seal lengths less than 20 feet are permissible only if shallow zones will be monitored and approval has been obtained from the enforcing agency. If possible, special protection shall be provided where a reduced-length seal is used, as described in Section 8 of the Water Well Standards.

2. **Other Monitoring Wells.** The upper annular seal shall extend from ground surface to a minimum depth of 20 feet. An annular seal less than 20 feet in length is permissible if provisions in Item 1, above, are followed.

3. **Sealing Off Strata.** Additional annular sealing material shall be placed below the minimum depth of the upper annular seal, as is needed, to prevent the movement of poor-quality water, pollutants, and contaminants through the well to zones of good-quality water. Requirements for sealing off zones are in Section 13 of the Water Well Standards.

4. **Shallow Water Level Observation Wells.** Water level observation wells less than 15 feet in total depth that are used to assess root zone drainage in agricultural areas are exempt from an annular surface seal requirement, unless otherwise required by the enforcing agency.

5. **Areas of Freezing.** The top of the annular seal may be below ground surface in areas where freezing is likely. Such areas include those listed in Section 9 of the Water Well Standards. The top of the annular seal shall not be more than 4 feet below ground surface. The remainder of the space above the seal may be made an integral part of a vault, in accordance with Section 10, Subsection E, page 45, below.

6. **Vaults.** At the approval of the enforcing agency, the top of the annular seal and well casing can be below ground surface where traffic or other conditions require. In no case shall the top of the annular seal be more than 4 feet below ground surface.

   The top of the annular seal shall contact a suitable, watertight, structurally-sound subsurface vault, or equivalent feature, that encloses the top of the well casing in accordance with Section 10, Subsection E, page 45, below. The vault shall extend from the top of the annular seal to at least ground surface.

**B. Sealing Conditions.**

1. **Temporary Conductor Casing.** If "temporary" conductor casing is used during drilling, it shall be removed during the placement of the casing and annular seal materials, as described in Section 9 of the Water Well Standards. If the temporary conductor casing "cannot" be removed, as defined in Section 9 of the Water Well Standards, sealing material shall be placed between the conductor casing and borehole wall, and between the well casing and conductor casing, in accordance with methods described in Section 9 of the Water Well Standards. Sealing material shall extend to at least the depths specified in Subsection A of this section.

2. **Permanent Conductor Casing.** If a permanent conductor casing is to be installed, the monitoring well borehole diameter shall be at least 4 inches greater than the outside diameter of the conductor casing. The inner diameter of the permanent conductor.
casing shall in turn be at least 4 inches greater than the outside diameter of the well casing.

Sealing material shall be placed between the permanent conductor casing and the borehole wall, and the conductor casing and the well casing. The sealing material shall extend to at least the depths specified in Subsection A of this section.

C. Radial Thickness of Seal. A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except as noted in Section 9 of the Water Well Standards. At least two inches of sealing material shall also be maintained between all "casings" in a borehole, within the interval to be sealed unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, to allow casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

D. Sealing Material. Sealing material shall consist of neat cement, sand-cement, or bentonite clay. Cement-based sealing material shall be used opposite fractured rock, unless otherwise approved by the enforcing agency. Concrete shall be used only with the approval of the enforcing agency.

Sealing material shall be selected based on required structural, handling, and sealing properties, and the chemical environment into which it is placed. Use of drilling mud or cuttings from drilling shall not be used for any part of sealing material.

1. Water. Water used for sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, shall be free of petroleum and petroleum products, and shall be free of suspended matter. Good-quality water is necessary to ensure that sealing materials achieve proper consistency for placement and achieve adequate structural and sealing properties.

Nonpotable water can sometimes be used for preparing cement-based sealing materials. In no case shall the concentration of chloride in water used in cement-based sealing material exceed 2,000 milligrams per liter. Sulfate shall not exceed 1,500 mg/l.

Water used for sealing material shall be chemically analyzed if unknown. Only drinking-quality water of known composition should be used for preparing sealing mixtures for monitoring wells to be used for sensitive water-quality determinations.

2. Cement-Based Sealing Materials. Discussion and standards for cement-based sealing materials are contained in Section 9 of the Water Well Standards. Special considerations that apply to monitoring wells are:

a. Additives. Care should be exercised in the use of special additives for cement-based sealing materials, such as those used for modifying cement setting times. Some additives could interfere with sensitive water quality determinations.

b. Cooling Water. In the case of water quality monitoring wells, care should be exercised in the use of circulating cooling water to protect plastic casing from heat build-up during setting of cement-based sealing materials. Water introduced and/or circulated in a well for cooling could interfere with water quality determinations.

3. Bentonite-Based Sealing Materials. Discussion and standards for bentonite-based sealing materials are contained in Section 9 of the Water Well Standards.
E. **Transition Seal.** A bentonite-based transition seal, up to 5 feet in length, is often placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grain sand, usually less than 2 feet in length, is often placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-grain forms of bentonite, such as granules and powder, are usually employed for a transition seal if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by using a tremie pipe or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in the well annulus in dry form or as slurry for transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where the bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration or to make a slurry shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, 1/2 to 1 hour is required for hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sounded to ensure that no bridging occurred during placement.

F. **Placement of Annular Seal Material.** All loose cuttings and other obstructions shall be removed from the annular space before sealing materials are placed. Sealing may be accomplished by using pressure grouting techniques, a tremie pipe, or equivalent. Sealing materials shall be installed as soon as possible during well construction operations. Sealing materials shall not be installed by "free-fall" from the surface unless the interval to be sealed is dry and less than 30 feet deep.

Casing spacers shall be used within the interval(s) to be sealed to separate individual well casing strings from one another in a borehole of a nested monitoring well. The spacers shall be placed at intervals along the casing to ensure a minimum separation of 2 inches between individual casing strings. Spacers shall be constructed of corrosion-resistant metal, plastic, or other non-degradable material. Wood shall not be used as spacer material.

Any metallic component of a spacer used with metallic casing shall consist of the same material as the casing. Metallic spacer components shall meet the same metallurgical specifications and standards as the casing to reduce the potential for galvanic corrosion of the casing.

The spacing of casing spacers is normally dictated by casing materials used, the orientation and straightness of the borehole, and the method used to install the casing. Spacers shall not be more than 12 inches in length and shall not be placed closer than 10 feet apart along a casing string within the interval to be sealed, unless otherwise approved by the enforcing agency.
Casing spacers shall be designed to allow the proper passage and distribution of sealing material around casing(s) within the interval(s) to be sealed.

Additional discussion and standards for placement of the annular seal are contained in Section 9, Section 13, and Appendix B of the Water Well Standards.

Section 10. Surface Construction Features.

Surface construction features of a monitoring well shall serve to prevent physical damage to the well; prevent entrance of surface water, pollutants, and contaminants; and prevent unauthorized access.

A. **Locking Cover.** The top of a monitoring well shall be protected by a locking cover or equivalent level of protection to prevent unauthorized access.

B. **Casing Cap.** The top of a monitoring well casing shall be fitted with a cap or "sanitary seal" to prevent surface water, pollutants, or contaminants from entering the well bore. Openings or passages for water level measurement, venting, pump power cables, discharge tubing, and other access shall be protected against entry of surface water, pollutants, and contaminants.

C. **Flooding.** The top of the well casing shall terminate above ground surface and known levels of flooding, except where site conditions, such as vehicular traffic, will not allow.

D. **Bases.** Unless otherwise approved by the enforcing agency, a concrete base or pad shall be constructed around the top of a monitoring well casing at ground surface and contact the annular seal, unless the top of the casing is below ground surface as provided by Subsection E, below. The base shall be at least 4 inches thick and shall slope to drain away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency.

The base shall be free of cracks, voids, and other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing must be water tight and must not cause the failure of the well casing or annular seal.

Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

E. **Vaults.** At the approval of the enforcing agency, the top of the well casing may be below ground surface because of traffic or other critical considerations. A structurally sound watertight vault, or equivalent feature, shall be installed to house the top of a monitoring well that is below ground surface. The vault shall extend from the top of the annular seal to at least ground surface. In no case shall the top of the annular seal be more than 4 feet below ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing, if any, shall not fail or cause the failure of the well casing or annular seal.

Where cement-based annular seal materials are used, the vault shall be set into or contact the annular seal material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault should be set into the bentonite before it is fully hydrated.
Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation. Bentonite-based sealing material may be used between the vault and excavation at the approval of the enforcing agency.

Sealing material surrounding a vault shall extend from the top of the annular seal to ground surface, unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be placed in a "continuous pour." In other words, cement-based sealing material shall be placed between the vault and excavation and contact the cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases, unless otherwise approved by the enforcing agency. The lid shall be fitted with a security device to prevent unauthorized access. The lid shall be clearly and permanently marked "MONITORING WELL." The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at or above grade so drainage is away from the vault. The top of the well casing contained within the vault shall be covered in accordance with requirements under Subsections A and B, above, so that water, contaminants, or pollutants that may enter the vault will not enter the well casing.

F. Protection From Vehicles. Protective steel posts, or the equivalent, shall be installed around a monitoring well casing where it is terminated above ground surface in areas of vehicular traffic. The posts shall be easily seen and shall protect the well from vehicular impact.

Additional requirements for surface construction features are in Section 10 of the Water Well Standards.

Section 11. Filter Pack.

Monitoring well filter pack material shall consist of nonreactive, smooth, rounded, spherical, granular material of highly uniform size and known composition. Filter pack material shall not degrade or consolidate after placement. The grain-size of the filter pack shall be matched to the slot size of the well screen so that any movement of filter pack material into the well will be limited to prevent significant voids in the filter pack that could ultimately destabilize the annular seal.

Filter pack material shall be obtained from clean sources. Filter pack material should be washed and properly packaged for handling, delivery, and storage, if used in monitoring wells constructed for sensitive water quality determinations.

Care should be exercised in the storage of filter pack materials at a drilling site to ensure the material does not come into contact with pollutants or contaminants. Care should also be exercised to prevent the introduction of foreign substances, such as clay or vegetative matter, that might interfere with the placement and function of the filter pack.

Filter pack material shall be placed in the well boring by use of a tremie pipe or equivalent. The depth of the top of the filter pack shall be carefully checked and the volume of emplaced filter pack material verified to determine that filter pack materials have not bridged during installation.
Section 12. Casing.

The term "casing" in its broadest sense includes all tubular materials that are permanent features of a well. Screens, collars, risers, liners, and blank casing in monitoring wells maintain the well bore and provide a passage for ground water level measurement and/or sample-collection devices.

Protective casing serves to prevent accidental or intentional damage to a well. Protective casing normally consists of heavy gauge metallic pipe placed over the portion of the well casing that extends above ground surface.

Conductor casing usually functions as a temporary means of shoring the walls of a well boring to allow drilling and the placement of well construction materials. If used, temporary conductor casing is usually driven into place during drilling and is withdrawn at the same time filter pack and annular seal materials are installed around the well casing. Sometimes conductor casing is left in place and is made a permanent feature of the completed well structure. Requirements for sealing permanent conductor casing in place are contained in Section 9.

For the purpose of these standards, the term "casing" applies to screens, collars, risers, and blank casing, and other specialized products used to maintain the well bore. General discussion and standards for casing materials are contained in Section 12 of the Water Well Standards. Special considerations that apply to monitoring well casing are described below:

A. Casing Material.

1. Chemical Compatibility. Special consideration shall be given to the selection of casing materials for monitoring wells installed in environments that are chemically "hostile". The selected casing shall resist chemical attack and corrosion.

Special consideration should be given to the selection of casing materials for wells to be used for sensitive water-quality determinations. Chemical interaction between casing materials and pollutants, contaminants, ground water, filter pack material, and geologic materials could bias ground-water quality determinations.

2. Used Casing. Used casing may be acceptable in certain cases, at the approval of the enforcing agency.

3. Plastic and Steel Casing. Plastic and steel well casing materials are commonly used for monitoring wells. The principal plastics used for water-quality monitoring wells are thermoplastics and fluorocarbon resins.

Standards for thermoplastic well casing are in Section 12 of the Water Well Standards. The principal thermoplastic material used for water quality monitoring wells is polyvinyl chloride (PVC).

Fluorocarbon casing materials include fluorinated ethylene propylene (FEP) and polytetrafluoroethylene (PTFE). Fluorocarbon resin casing materials are generally considered immune to chemical attack. Fluorocarbon casing materials shall meet the following specifications, including the latest revisions thereof:
   b. ASTM D3295, Standard Specifications for PTFE Tubing.
Stainless steel is the most common form of metallic casing used in monitoring wells constructed for sensitive water quality determinations. Stainless steel casing shall meet the provisions of ASTM A312, Standard Specification for Seamless and Welded Austenitic Stainless Pipe, and shall meet general requirements for tubular steel products in Section 12 of the Water Well Standards.

B. **Multiple Screens.** Monitoring well casing strings shall not have openings in multiple water-bearing units (multi-level monitoring wells), if poor-quality water, pollutants, or contaminants in units penetrated by the well could pass through the openings and move to other units penetrated by the well and degrade ground water quality, unless otherwise approved by the enforcing agency.

C. **Bottom Plug.** The bottom of a monitoring well casing shall be plugged or capped to prevent sediment or rock from entering the well.

D. **Casing Installation.** Discussion and standards for the installation of casing materials are in Section 12 of the Water Well Standards. Special considerations for monitoring wells are:

1. **Cleanliness.** Casing, couplings, centralizers, and other components of well casing shall be clean and free of pollutants and contaminants at the time of installation.

2. **Joining Plastic Casing.** Depending on the type of material and its fabrication, plastic casing shall be joined (threaded or otherwise coupled) in a manner that ensures its water tightness. Organic solvent welding cements or glues should not be used for joining plastic casing if glues or cement compounds could interfere with water-quality determinations.

3. **Impact.** Casing shall not be subjected to significant impact during installation that may damage or weaken the casing.

Section 13. Well Development.

Monitoring well development, redevelopment, and reconditioning shall be performed with care so as to prevent damage to the well and any strata surrounding the well that serve to restrict the movement of poor-quality water, pollutants, and contaminants. Development, redevelopment, and reconditioning operations shall be performed with special care where a well has been constructed in an area of known or suspected pollution or contamination. Such special care is necessary to prevent the spread of pollutants and contaminants in the environment and to protect public health and safety.

Water, sediment, and other waste removed from a monitoring well for "development" operations shall be disposed of in accordance with applicable federal, State, and local requirements. The enforcing agency should be contacted concerning the proper disposal of waste from development operations.

Appropriate methods of well development vary with the type and use of a monitoring well. Development methods that may be acceptable under certain circumstances include:

A. **Mechanical Surging.** Plungers, bailers, surge blocks, and other surging devices shall incorporate safety valves or vents to prevent excessive pressure differentials that could damage casing or screen.
B. Overpumping and Pump Surging. Overpumping and surging may not be suitable for development of wells producing large amounts of sediment because of the potential for clogging or jamming of pumps.

C. Air Development. Some air development methods are not acceptable for monitoring wells to be used for sensitive water-quality determinations.

D. Water Jetting. Water used in jetting operations shall be free of pollutants and contaminants. Water-jetting methods are not always acceptable for monitoring wells used for sensitive water-quality determinations.

E. Chemical Development. Extreme care shall be exercised in the use of chemicals for monitoring well development. It is often unacceptable to use chemicals for developing monitoring wells to be used for water-quality determinations. Chemicals introduced for development shall be completely removed from the well, filter pack, and water-bearing strata accessed by the well immediately after development operations are completed.

The various methods described above are sometimes used in combination.

Section 14. Rehabilitation and Repair of Monitoring Wells.

For the purpose of these standards, "well rehabilitation" includes the treatment of a well to recover loss in yield caused by incrustation or clogging of the screen, filter pack, and/or water-bearing strata adjoining the well. Well rehabilitation methods that may, in certain cases, be acceptable for monitoring wells include mechanical surging, backwashing or surging by alternately starting or stopping a pump, surging with air, water jetting, sonic cleaning, chemical treatment, or combinations of these.

Rehabilitation methods shall be performed with care to prevent damage to the well and any barriers that serve to restrict the movement of poor-quality water, pollutants, or contaminants. Chemicals used for rehabilitation shall be completely removed from the well, filter pack, and water-bearing strata accessed by the well immediately after rehabilitation operations are completed. Chemicals, water, and other waste shall be disposed of in accordance with applicable federal, State, and local requirements. The enforcing agency should be contacted regarding the proper disposal of waste from rehabilitation operations.

Rehabilitation methods should be compatible with the use of the monitoring well. Special care should be given to the selection of rehabilitation methods for water-quality monitoring wells.

Materials used for repairing well casing shall meet the requirements of Section 12 of these standards.

Section 15. Temporary Cover.

The well or borehole opening and any associated excavations shall be covered at the surface to ensure public safety and to prevent the entry of foreign material, water, contaminants, and pollutants whenever work is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.
Part III. Destruction of Monitoring Wells

Section 16. Purpose of Destruction.

A monitoring well or exploration hole subject to these requirements that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

1. Ensure the quality of ground water is protected, and,
2. Eliminate a possible physical hazard to humans and animals.

Section 17. Definition of "Abandoned" Monitoring Well.

A monitoring well is considered "abandoned" or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. In some cases, regulatory agencies may require that an inactive monitoring well be maintained for future use.

In accordance with Section 24400 of the California Health and Safety Code, the monitoring well owner shall properly maintain an inactive well, as evidence of intention for future use. In such a way that the following requirements are met:

1. The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.
2. The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.
3. The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.
4. The area surrounding the well shall be kept clear of brush, debris, and waste materials.

Section 18. General Requirements.

All permanently inactive or "abandoned" monitoring wells and exploration holes subject to these requirements shall be properly destroyed. The purposes of destruction are to eliminate the well structure and borehole as a possible means for the preferential migration of poor-quality water, pollutants, and contaminants; and, to prevent a possible hazard to humans and animals.
Section 19. Requirements for Destroying Monitoring Wells and Exploration Holes.

General requirements for destroying monitoring wells and exploration holes are contained in Section 23 of the Water Well Standards. Special considerations for monitoring wells and exploration holes are as follows.

A. Monitoring Wells. Monitoring wells shall be destroyed in accordance with the following requirements and Section 23 of the Water Well Standards, irrespective of their original date of construction.

1. Preliminary Work. A monitoring well shall be investigated before it is destroyed to determine its condition and details of its construction. The well shall be sounded immediately before it is destroyed to make sure no obstructions exist that will interfere with filling and sealing.

The well shall be cleaned before destruction as needed so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction, are removed for disposal.

The enforcing agency shall be notified as soon as possible if pollutants or contaminants are known or suspected to be present in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of all materials removed from a well to be destroyed.

2. Sealing Conditions. The following minimum requirements shall be followed when various conditions are encountered.

a. The monitoring well casing, and any other significant voids within the well, shall, at a minimum, be completely filled with sealing material, if the following conditions exist:
   - The monitoring well is located in an area of known or potential pollution or contamination, and,
   - The well was constructed and maintained in accordance with these standards.

Sealing material may have to be placed under pressure to ensure that the monitoring well is properly filled and sealed.

b. A monitoring well shall be destroyed by removing all material within the original borehole, including the well casing, filter pack, and annular seal; and the created hole completely filled with appropriate sealing material, if the following conditions exist:
   - The well is located in an area of known or potential pollution or contamination, and,
   - The well’s annular seal, casing, screen, filter pack, or other components were not constructed or maintained according to these standards so that well destruction by merely filling the well casing with sealing material, as in "a" above, would not prevent potential water-quality degradation from
the movement of poor-quality water, pollutants, or contaminants through
the destroyed well structure.

Material to be extracted from the original borehole shall be removed by
means of drilling, including overdrilling, if necessary. The enforcing agency
should be contacted to determine requirements for proper disposal of
removed materials.

Casing, filter pack, and annular seal materials may be left in place during
sealing operations, if the enforcing agency agrees they cannot or should not
be removed. In such a case, appropriate sealing material shall be placed in
the well casing, filter pack, and all other significant voids within the entire
well boring. Casing left in place may require perforation or puncturing to
allow proper placement of sealing materials. Sealing material may have to be
applied under pressure to ensure its proper distribution.

c. Monitoring wells shall, at a minimum, be destroyed in accordance with the
requirements of Section 23 of the Water Well Standards if located in an area
free of any known or potential contamination or pollution.

B. Exploratory Borings. Exploratory borings shall be completely filled with appropriate sealing
material from bottom to top, if located in areas of known or suspected contamination or
pollution. Borings located outside such areas shall, at a minimum, be filled with sealing
material from ground surface to the minimum depths specified in Section 23 of the Water Well
Standards. Additional sealing material shall be placed below the minimum surface seal where
needed to prevent the interchange of poor-quality water, pollutants, or contaminants between
strata penetrated by the boring.

Appropriate fill or sealing material shall be placed below and between intervals containing
sealing material. Sealing material is often economical to use as fill material.

The boring shall be inspected immediately prior to filling and sealing operations. All
obstructions and pollutants and contaminants that could interfere with filling and sealing
operations shall be removed prior to filling and sealing. The enforcing agency shall be notified
as soon as possible if pollutants or contaminants are known or suspected to be in a boring to
be destroyed. Well destruction operations may then proceed only at the approval of the
enforcing agency. The enforcing agency should be contacted to determine requirements for
proper disposal of removed materials.

C. Placement of Material. The placement of sealing material for monitoring wells and exploratory
borings is generally described in Section 23 and Appendix B of the Water Well Standards. The
following additional requirements shall be observed when placing sealing material for
monitoring well or exploratory boring destruction.

1. Placement Method. The well or exploratory boring shall be filled with appropriate
sealing, and fill material where allowed, using a tremie pipe or equivalent, proceeding
upward from the bottom of the well or boring.

Sealing material shall be placed by methods (such as the use of a tremie pipe or
equivalent) that prevent freefall, bridging, and dilution of sealing materials, and/or
prevent separation of aggregate from sealants. Sealing material may be placed by
freefall only where the interval to be sealed is dry and no more than 30 feet in depth. Fill material shall be placed by methods that prevent bridging and voids.

2. **Timing of Placement.** Sealing material shall be placed in one continuous operation (or "pour") from the bottom to the top of the well or boring, unless conditions in the well or boring dictate that sealing operations be conducted in a staged manner, and prior approval is obtained from the enforcing agency.

3. **Ground Water Flow.** Special care shall be used to restrict the flow of ground water into a well or boring while placing sealing and fill material, if subsurface pressure producing the flow is significant.

4. **Sealing Pressure.** Pressure required for the placement of cement-based sealing materials shall be maintained long enough for cement-based sealing materials to properly set.

5. **Verification.** It shall be verified that the volume of sealing and fill material placed during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determine whether the well or boring has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.

D. **Sealing and Fill Materials.** Materials used for sealing exploratory borings and monitoring wells shall have low permeabilities so that the volume of water and possible pollutants and contaminants passing through them will be of minimal consequence. Sealing material shall be compatible with the chemical environment into which it is placed, and shall have mechanical properties consistent with present and future site uses.

Suitable sealing materials include neat cement, sand-cement, and bentonite, all of which are described in Section 9 of these standards. Bentonite shall not be used as a sealing material opposite zones of fractured rock, unless otherwise approved by the enforcing agency. Drilling mud or drill cuttings are not acceptable as any part of sealing material for well destruction. Concrete may be used as a sealing material at the approval of the enforcing agency.

Fill material, if any, shall meet the requirements of Section 23 of the Water Well Standards. Fill material shall be free of pollutants and contaminants and shall not be subject to decomposition or consolidation after placement. Drilling mud or cuttings are not acceptable as any part of fill material.

E. **Additional Requirements for Monitoring Wells and Exploratory Borings in Urban Areas.** The following additional requirements shall be met for destroying monitoring wells and exploratory borings in urban areas, unless otherwise approved by the enforcing agency:

1. The upper surface of the sealing material shall end at a depth of 5 feet below ground surface; and,

2. If the well casing was not extracted during destruction and sealing operations, a hole shall be excavated around the well casing to a depth of 5 feet below ground surface after sealing operations have been completed and the sealing material has adequately set and cured. The exposed well casing shall then be removed by cutting the casing at the bottom of the excavation. The excavation shall be backfilled with clean, native soil or other suitable material.
F. **Temporary Cover.** The well or borehole opening and any associated excavations shall be covered at the surface to ensure public safety and to prevent the entry of foreign material, water, pollutants, and contaminants; whenever work is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed, except by equipment or tools.
CATHODIC PROTECTION WELLS
CATHODIC PROTECTION WELL STANDARDS

INTRODUCTION

Most wells in California are constructed to extract ground water, inject water, or monitor ground water conditions. Other, less common types of wells include cathodic protection wells. Cathodic protection wells, sometimes called "deep groundbeds," house devices to minimize electrolytic corrosion of metallic pipelines, tanks, and other facilities in contact with the ground.

Electrolytic Corrosion

For the purpose of these standards, electrolytic corrosion is defined as the deterioration of metallic objects by electrochemical reaction with the environment. The electrolytic corrosion process is illustrated in Figure 4 for a metallic pipeline in a soil-water environment. This process gradually weakens the pipeline and can cause its failure.

In Figure 4, an electric potential is induced on the surface of the pipeline as a result of variations in the concentrations of salts in the soil and water surrounding the pipeline. This potential results in an electric current in the soil-water electrolyte. Current flows from an "anode area" on the pipeline to a "cathode area" on the pipeline. Metal is removed from the anode area by the current.

Cathodic Protection

"Cathodic protection" is a term used for certain measures taken to prevent or minimize electrolytic corrosion of metallic equipment and structures. Cathodic protection devices redirect current to flow from a "sacrificial" anode to the soil-water electrolyte, instead of from an anode area on a pipeline or other metallic structure to be protected. The protective anode's role is to corrode in place of the metallic object it is designed to protect, as shown in Figure 5. The protected facility is made to be a permanent cathode by use of cathodic protection devices. Thus, the facility is said to be "cathodically protected."

Protective or sacrificial anodes can be placed close to ground surface or at significant depth. Anodes have been placed at shallow depths in horizontal and vertical arrays for many years. Shallow arrays are often not well suited for metropolitan areas because of land requirements, or suited for areas where electrical interference may be high.

Deep vertical anode installations, usually referred to as "cathodic protection wells," were first developed and used during the 1940s. They were developed in response to the constraints of shallow anode arrays.

Cathodic Protection Wells

Cathodic protection wells are widely installed to protect metallic objects in contact with the ground from electrolytic corrosion. Such objects include petroleum, natural gas, and water pipelines, and related storage facilities; power lines; telephone cables; and switchyards. Cathodic protection wells are sometimes used to control electrolytic corrosion in large water wells.
Figure 4. ELECTROLYTIC CORROSION OF A BURIED PIPELINE
(NOTE: Schematic, not to scale)
Figure 5. CATHODIC PROTECTION OF A BURIED PIPELINE
(NOTE: Schematic, not to scale)
Many cathodic protection wells have been constructed to protect pipelines that transport natural gas or other "hazardous" materials. The Natural Gas Pipeline Safety Act, Public Law 90-481 adopted by Congress in August 1968, provides requirements for cathodic protection of certain pipelines.

Most cathodic protection wells in California are located in areas where underground pipelines or "conveyance" systems are numerous and must be protected. These areas include:

- South coastal region from San Diego to Santa Barbara,
- Oil-producing areas of the southern San Joaquin Valley and the Central Coast, and,
- San Francisco Bay Area.

Few cathodic protection wells exist in California north of Sacramento.

Many cathodic protection wells, as illustrated in Figure 6, have been constructed by:

1. Drilling a 6- to 12-inch diameter borehole to a desired depth. Cathodic protection wells normally range from 100 to 500 feet in total depth. A few wells have been constructed to depths of 800 feet.

   California Water Code Section 13711 defines a "cathodic protection well" as an anode installation exceeding 50 feet in depth. Installations less than 50 feet deep are "legally" considered "shallow anodes," not cathodic protection wells. Shallow anode installations are not specifically covered by these standards.

2. Placing a string of anodes in the borehole within a designated interval, usually referred to as the "anode interval."

3. Backfilling the anode interval around the anodes with an electrically conductive material, such as granular coke.

4. Installing a small-diameter vent pipe that extends from the top of the anode interval to land surface, or above. The purpose of the vent pipe is to release generated gases. Medium to large-diameter pipe or casing used in water wells to maintain the well bore and house pumping equipment is not normally used for cathodic protection wells.

5. Backfilling the annulus between the vent pipe and borehole wall with an electrically non-conductive fill material to a specific height above the anode interval. Such fill material usually consists of uniform, small-diameter gravel. Its purpose is to provide a permeable medium for migration of gases and to stabilize the walls of the borehole.

   In the past this material was sometimes used to fill the annulus between the vent pipe and the borehole wall from the top of the anode interval to land surface. These standards require specific intervals of the upper annular space of a cathodic protection well be filled with sealing materials instead of gravel, to protect ground water quality.

6. Sealing the annulus between the vent pipe and the borehole wall, from the top of the non-conductive annular fill to land surface, with sealing material.

7. Installing a permanent cover over the well at ground surface.

8. Connecting the anode leads to the facility to be protected, possibly through an electrical current source.

Individual designs of cathodic protection wells vary.
Figure 6. CROSS SECTION OF A TYPICAL CATHODIC PROTECTION WELL
(NOTE: Schematic, not to scale)

- Vented Cap or "U" Bend
- Vault with Cover
- Direct Current Source (Rectifier)
- Ground Surface
- Electrical Cable (Sometimes Run Outside of Vent Pipe)
- Annular Space (2" Minimum)
- Annular Seal (Extends to at least 20' from ground surface)
- Non-Conductive Backfill
- Buried Pipeline to be protected
- Vent Pipe (Casing)
- Conductive Backfill
- Borehole
- Anodes

[Diagram of cathodic protection well with labeled components]
The protective anodes of a cathodic protection well usually corrode away with time. Thus a cathodic protection well’s anodes determine the well’s useful life. Anodes are usually designed to last 15 to 20 years.

There has been an increasing tendency to construct cathodic protection wells with large diameter vent pipe or casing so that anodes can be replaced through the casing. Anode replacement through casing eliminates the need to drill replacement wells when anodes have been expended.

**Corrosion Coordinating Committees**

Serious electrical interference problems can occur where cathodic protection networks criss-cross one another or are too close to one another. Also, stray currents produced from electrical transmission lines and other equipment can sometimes interfere with the operation of cathodic protection systems. Interference problems are usually most pronounced in urban areas.

Corrosion control coordinating organizations have been formed in areas of California to overcome system interferences and other problems. Most organizations are affiliated with or are chapters of the National Association of Corrosion Engineers.

Corrosion control organizations represent the majority of utilities and other groups that install cathodic protection devices, including cathodic protection wells. Organization members coordinate the installation and operation of cathodic protection facilities with the goal of minimizing problems of electrical interference.

Four organizations that deal with Central and Southern California, are:

- **Southern California**
  The Southern California Cathodic Protection Committee is a formal committee covering all of Southern California south of San Luis Obispo, Kern, and Inyo counties, except San Diego County.

- **San Diego County**
  The San Diego County Underground Corrosion Control Committee is an informal organization that deals with the San Diego area.

- **Central California**
  The Central California Cathodic Protection Committee is a formal committee covering all of Central California plus Sacramento Valley counties, and western Sierra Nevada mountain counties south of Plumas County.

- **San Francisco Bay Area**
  The activities of the two committees that formerly covered the San Francisco Bay Area have been assumed by the San Francisco Section of the National Association of Corrosion Engineers. The committees were disbanded in 1985.

No coordinating organizations function in coastal counties north of San Francisco or in the northeastern part of the State.

Unfortunately, not all who install and operate cathodic protection facilities work with a corrosion coordinating organization. Those not associated with an organization are usually individuals or local agencies that are sometimes unaware of the existence of other installations. Non-coordinated facilities can seriously interfere with one another electrically.
Need for Cathodic Protection Well Standards

Cathodic protection wells, along with other types of wells, can allow groundwater quality degradation to occur. Improperly constructed or destroyed cathodic protection wells can constitute a preferential pathway for the movement of poor-quality water, pollutants, and contaminants. Cathodic protection wells constructed with gravel backfill to land surface are particularly conducive to the movement of poor-quality water, pollutants, or contaminants.

Water and electrolytes are sometimes introduced into cathodic protection wells through vent pipes, or gravel fill in the annulus, to keep wells functional where natural electrolytes are lacking. Such a practice could be considered "waste disposal" and may be illegal if poor-quality water is used.

Permanently inactive cathodic protection wells pose a threat for the movement of poor-quality water, pollutants, and contaminants, and should be properly destroyed. Permanently inactive cathodic protection wells are a threat to ground water quality because they become dilapidated with time, are sometimes forgotten, and are sometimes used for waste disposal.

Many cathodic protection wells have small diameter vent pipes that prevent entry by persons and most animals. However, large vent pipe sizes can pose a serious safety threat if left open at land surface.

History of Cathodic Protection Well Standards


Cathodic protection well standards for California were first published in 1973 as DWR Bulletin 74-1, Cathodic Protection Well Standards: State of California. Standards presented here replace those contained in Bulletin 74-1. Additional discussion on the history of well standards is contained in the "Introduction" section of this supplement (Bulletin 74-90) and Bulletin 74-81, Water Well Standards: State of California.

Scope of Standards

The following are recommended minimum standards for construction, alteration, maintenance, and destruction of cathodic protection wells in California. They only serve as minimum guidelines toward ensuring cathodic protection wells do not constitute a significant pathway for movement of poor-quality water, pollutants, and contaminants. These standards do not ensure a cathodic protection well will perform its corrosion protection function adequately.

The functional requirements of cathodic protection wells may conflict with the application of certain standards for the protection of water quality. Consequently, some compromise has been made between well function and resource protection in the development of these standards.

Organization of Standards

These standards are arranged in a format similar to the Water Well Standards. Since many of the standards that apply to water wells also apply to cathodic protection wells, many references are made in these standards to the Water Well Standards. Standards that apply only to cathodic protection wells or that require emphasis for cathodic protection wells, are discussed in detail in these standards.
STANDARDS

Part I. General

Section 1. Definitions¹.

A. Cathodic Protection Well. A cathodic protection well is defined in Section 13711 of the California Water Code as:

"any artificial excavation in excess of 50 feet constructed by any method for the purpose of installing equipment or facilities for the protection electrically of metallic equipment in contact with the ground, commonly referred to as cathodic protection."

B. Enforcing Agency. An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of cathodic protection wells.

C. Casing. All vent pipe, anode access tubing, electrical cable conduit, and other tubular materials that pass through the interval to be sealed.

D. Conductor Casing. A tubular retaining structure temporarily or permanently installed in the upper portion of the well boring between the wall of the well boring and the inner well casing. Conductor casing is often installed to keep the borehole open during drilling if caving conditions are expected. Despite its title, conductor casing does not normally serve an "electrical" function for cathodic protection wells.

Section 2. Exemptions Due to Unusual Conditions.

Under certain circumstances the enforcing agency may waive compliance with these standards and prescribe alternate requirements. These standards may be waived only where they are impractical or ineffective because of unusual conditions, or would result in unsatisfactory condition or well function. In waiving any of these standards, the enforcing agency shall, if at all possible, require that measures be implemented to provide the same or greater level of water-quality protection that would otherwise be provided by these standards.

Section 3. Special Standards.

The enforcing agency may prescribe measures more stringent than standards described here, where needed to protect public safety or protect water quality.

Section 4. Responsible Parties.

Corrosion control engineers are normally responsible for the design and supervision of corrosion control facilities incorporating cathodic protection wells. Pursuant to Section 13750.5 (Division 7, Chapter 10, Article 3) of the California Water Code, construction, alteration, and destruction of cathodic protection wells shall be performed by contractors licensed in accordance with the California Contractors' License Law.

¹ Technical terms are defined in Appendix A, page 77.
(Division 3, Chapter 9, California Business and Professions Code), except where exempted by law. Above-ground electrical facilities for cathodic protection wells should be installed by an appropriately licensed contractor.

Section 5. Reports.

Cathodic protection well construction, alteration, and destruction reports shall be completed on forms provided by the California Department of Water Resources. Other types of forms may be used for submission to the Department with the prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant provisions of Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in *Guide to the Preparation of the Water Well Drillers Report*, Department of Water Resources, October, 1977, or its latest revision.
Part II. Cathodic Protection Well Construction

Section 6. Well Location With Respect to Pollutants and Contaminants, and Structures.

A. Separation. Cathodic protection wells shall be located an adequate distance from known or potential sources of pollution or contamination, where site constraints and corrosion control considerations allow. Potential sources of pollution and contamination include those listed in Section 8 of the Water Well Standards.

As specified in Section 7 below, the length of the annular seal for a cathodic protection well shall be increased if the well is located in a congested urban area, or is located within 100 feet of any potential source of pollution or contamination.

B. Flooding and Drainage. Cathodic protection wells should be located in areas protected from flooding, if possible. Wells located in areas of flooding shall be protected from flood waters and drainage, including protective measures outlined in Section 8, below.

Ground surface surrounding a cathodic protection well shall slope away from the well. Drainage from areas surrounding a cathodic protection well shall be directed away from the well.

C. Accessibility. All cathodic protection wells shall be located an adequate distance from buildings and other structures to allow access for well maintenance, modification, repair, and destruction, unless otherwise approved by the enforcing agency.

Section 7. Sealing the Upper Annular Space.

The space between the cathodic protection well casing and the wall of the well boring, often referred to as the “annular space,” shall be effectively sealed to prevent it from being a preferential pathway for the movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of the annular seal are to stabilize the borehole wall, protect casing from degradation or corrosion, and ensure the structural integrity of the casing.

General discussion of sealing requirements and methods is contained in Section 9, Section 13, and Appendix B of the Water Well Standards. Special requirements for sealing cathodic protection wells are:

A. Minimum Depth of Annular Seal.

1. Minimum Depth. The annular space shall be filled with appropriate sealing material from ground surface to a depth of at least 20 feet below land surface. The annular space shall be sealed to a depth of at least 50 feet below land surface in congested urban areas, or where a cathodic protection well is within 100 feet of any potential source of pollution or contamination. Additional annular sealing material shall be installed to greater depths where adverse conditions exist that increase the risk of pollution or contamination of ground water.

2. Fill. Any annular space existing between the base of the annular surface seal and the top of the anode and conductive fill interval shall be filled with appropriate fill or sealing material. Fill material should consist of washed granular material such as sand, pea gravel, or sealing material. Fill material shall not be subject to decomposition or
consolidation after placement and shall be free of pollutants and contaminants. Fill material shall not contain drill cuttings or drilling mud. Sealing material is often more practical and economical to use for filling the annular space than granular material.

3. **Sealing-Off Strata.** Additional annular sealing material shall be placed below the minimum depth of the annular surface seal, as needed, to prevent the movement of poor-quality water, pollutants, and contaminants through the well to zones of good-quality water. Requirements for sealing off zones are in Section 10, below.

B. **Sealing Conditions.** Requirements for sealing the annular space under varied conditions are detailed in Section 9, Subsection B of the Water Well Standards.

C. **Radial Thickness of Seal.** A minimum of 2 inches of sealing material shall be maintained between all casings and the borehole wall within the interval to be sealed, except where temporary conductor casing cannot be removed as noted in Section 9 of the Water Well Standards. At least 2 inches of sealing material shall be maintained between all casings in a borehole, within the interval to be sealed unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, to allow casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

D. **Sealing Material.** Sealing material shall consist of neat cement, sand-cement, concrete, or bentonite clay as discussed in Section 9 of the Water Well Standards. Cement-based sealing material shall be used opposite zones of fractured rock used. Concrete shall only be used at the approval of the enforcing agency. Drill cuttings and used drilling mud shall not be used as any part of sealing material.

E. **Placement of Seal.** Standards for the placement of annular seals are described in Section 9 and Appendix B of the Water Well Standards.

Section 8. Surface Construction Features.

Surface construction features of a cathodic protection well shall serve to prevent physical damage to the well; prevent the entry of surface water, pollutants, and contaminants; and prevent unauthorized access.

A. **Locking Cover.** The top of a cathodic protection well shall be protected by a locking cover or equivalent level of protection to prevent unauthorized access. All such covers shall allow the venting of gases.

B. **Casing Cap.** The top of a cathodic protection well casing shall be fitted with a watertight cap, cover, “U” bend, or equivalent device to prevent the entry of water, pollutants, and contaminants into the well bore. All such covers shall allow venting of gases from the well.

C. **Flooding.** The top of the well casing shall terminate above ground surface and known levels of flooding, except where site conditions, such as vehicular traffic, will not allow.

D. **Bases.** A concrete base or pad shall be constructed around the top of a cathodic protection well casing at ground surface and contact the annular seal, unless the top of the casing is to be below ground surface as provided by Subsection E, below. The base shall be at least 4 inches thick and shall slope to drain away from the well casing. The base shall extend at least
2 feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency.

The base shall be free of cracks, voids, and other significant defects likely to prevent watertightness. Contacts between the base and the annular seal, and the base and the well casing must be watertight and must not cause the failure of the well casing or annular seal.

Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

E. **Vaults.** At the approval of the enforcing agency, the top of a cathodic protection well may be below ground surface because of traffic or other critical considerations. A watertight, structurally-sound vault, or equivalent feature, shall be installed to house the top of the well casing if it terminates below ground surface.

The vault shall extend from the top of the annular seal to at least ground surface. In no case shall the top of the annular seal be more than 4 feet below ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally-sound connection. Contacts between the vault and the annular seal, and the vault and the well casing (if any), shall not fail, or cause the failure of the well casing or annular seal.

Where cement-based annular sealing materials are used, the vault shall be set into or contact the annular sealing material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault shall be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation.

Sealing material surrounding the vault shall extend from the top of the annular seal to ground surface, unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be emplaced in a "continuous pour." In other words, cement-based sealing material shall be placed between the vault and excavation and contact a cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access and shall be clearly and permanently labeled "CATHODIC PROTECTION WELL." The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at grade, or above, so that drainage is away from the vault. The top of the casing contained within the vault shall be capped in accordance with requirements of Subsection B, above so that water, contaminants, and pollutants that may enter the vault will not enter the well casing.

F. **Protection From Vehicles.** Protective steel posts, or the equivalent, shall be installed around a cathodic protection well casing where it is terminated above ground surface in areas of vehicular traffic. The posts shall be easily seen and shall protect the well from vehicular impact.
Additional requirements for surface construction features are contained in Section 10 of the Water Well Standards.

Section 9. Casing.

Vent pipe, anode access tubing, and any other tubular materials that pass through the interval to be filled and sealed are all considered casing for the purpose of these standards. Materials used for cathodic protection well casing generally shall meet the requirements for casing materials and their installation in Section 12 of the Water Well Standards. Variance from the standards shall be at the approval of the enforcing agency. It is recommended that practices prescribed by the National Association of Corrosion Engineers also be followed in the design and installation of gas vents and electrical conduit.

Cathodic protection well casing should be at least 2 inches in internal diameter to facilitate eventual well destruction.

Section 10. Sealing-Off Strata.

If a cathodic protection well penetrates a stratum or strata below the minimum required annular surface seal depth specified in Section 7, above and that stratum contains poor-quality water, pollutants, or contaminants that could mix with and degrade water contained in other strata penetrated by the well, additional annular sealing material shall be placed below the minimum required annular surface seal to prevent mixing and water-quality degradation.

The following minimum requirements shall be observed for isolating zones containing poor-quality water, pollutants, or contaminants for various cases:

Case 1. Upper Stratum. If a stratum containing poor-quality water, pollutants, or contaminants lies above a stratum to be protected, annular seal material shall extend from the top of the stratum containing the poor-quality water, pollutants, or contaminants down to at least 10 feet into the confining layer separating the two strata, or through the entire thickness of the confining layer, whichever is least.

Case 2. Lower Stratum. If a stratum containing poor-quality water, pollutants, or contaminants lies below a stratum to be protected, the annular space opposite the stratum to be protected shall be sealed along its full length. The seal shall extend at least 10 feet into the confining layer separating the two strata, or through the entire thickness of the confining layer, whichever is least.

Case 3. Multiple Strata.

a. Where two or more strata containing poor-quality water, pollutants, or contaminants are adjacent to one another and overlie a stratum to be protected, the annular space opposite the strata containing poor-quality water, pollutants, or contaminants and opposite all interbedded confining layers shall be sealed. The annular seal shall extend at least 10 feet down into, or completely through, whichever is least, the confining layer separating the strata containing poor-quality water, pollutants, or contaminants and the underlying stratum to be protected.

b. Where two or more strata containing poor-quality water, pollutants, or contaminants underlie a stratum to be protected, the annular space opposite the stratum to be protected shall be sealed. The seal shall continue down at least 10 feet into, or completely through, whichever is least, the confining layer separating the stratum to be protected and the underlying strata containing poor-quality water, pollutants or contaminants.
c. Where two strata containing poor-quality water, pollutants, or contaminants are separated by a stratum to-be protected, the annular space opposite the stratum to be protected, the confining strata underlying and overlying the stratum to be protected, and the upper stratum containing poor-quality water, pollutants, or contaminants shall be sealed off.

The supplementary seals described in the cases above shall be extended up to and contact the base of the required minimum annular surface seal described in Section 7 above, if they are otherwise required to be within 10 feet of the surface seal. Sealing the entire annulus above the anode interval will often economically fulfill the conditions outlined above.

Requirements for sealing materials and their placement are described in Section 7, above.

Section 11. Repair of Cathodic Protection Wells.

Materials used for repairing cathodic protection well casing shall meet the requirements of Section 9, above.

Section 12. Temporary Cover.

The well or borehole opening and any associated excavations shall be covered at the surface to prevent the entry of foreign material, water, pollutants, and contaminants, and to ensure public safety whenever work is interrupted by such events as overnight shutdown, poor weather and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.
Part III. Destruction of Cathodic Protection Wells

Section 13. Purpose of Destruction.

A cathodic protection well that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

(1) Ensure the quality of ground water is protected, and,

(2) Eliminate a possible physical hazard to humans and animals.

Section 14. Definition of "Abandoned" Cathodic Protection Well.

A cathodic protection well is considered "abandoned" or permanently inactive when its anodes are exhausted and cannot, or will not, be replaced. A cathodic protection well is also considered "abandoned" or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use it again. To provide evidence of intention for future use of a well, the well owner, in accordance with Section 24400 of the Health and Safety Code, shall maintain the well in such a way that the following requirements are met:

"(1) The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.

(2) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(3) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

Section 15. General Requirements.

All permanently inactive or "abandoned" cathodic protection wells shall be properly destroyed. The purpose of destruction is to prevent a possible safety hazard to humans and animals and to eliminate the well structure as a possible means for the preferential migration of poor-quality water, pollutants, and contaminants.

Section 16. Requirements for Destroying Cathodic Protection Wells.

General requirements for well destruction are contained in Section 23 of the Water Well Standards. Special considerations for cathodic protection wells are as follows:

A. Preliminary Work. A cathodic protection well shall be investigated before it is destroyed to determine its condition, details of its construction and whether conditions exist that will interfere with filling and sealing.
The well shall be sounded immediately before it is destroyed to make sure that no obstructions exist that will interfere with filling and sealing. The well shall be cleaned before destruction, as needed, to ensure that all undesirable materials, including obstructions to filling and sealing, debris, and pollutants and contaminants that could interfere with well destruction are removed for disposal. The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed.

B. Filling and Sealing Conditions. The following minimum requirements shall be followed when various conditions are encountered.

1. Wells that only penetrate unconsolidated material and a single "zone" of ground water. At a minimum, the upper 20 feet of the well casing and the annulus between the well casing and borehole well (if not already sealed) shall be completely sealed with suitable material. Sealing material shall extend to a minimum depth of 50 feet below land surface if the well to be destroyed is located in an urban area, or is within 100 feet of any potential source of pollution or contamination. Additional sealing material may be needed if adverse conditions exist. The remainder of the well below the minimum surface seal shall be filled with suitable granular fill material, such as clean sand or pea gravel, or with sealing material.

2. Wells that penetrate several water-bearing strata. The upper portion of the well casing and annular space shall be filled with sealing material as described in Item 1, above. Strata encountered below the surface seal that contain poor-quality water, pollutants, or contaminants that could mix with and degrade water in other strata penetrated by the well, shall be effectively isolated by sealing the well bore and annulus within intervals specified in Section 10, above. The remainder of the well shall be filled with suitable granular fill or sealing material.

3. Wells penetrating fractured rock. Sealing material shall be installed as outlined in Items 1 and 2, above. Cement-based sealing material shall be used opposite fractured rock. The remainder of the well shall be filled with fill or sealing material, as appropriate.

4. Wells in nonfractured consolidated strata. Sealing material shall be installed as outlined in Items 1 and 2, above. The remainder of the well shall be filled with fill or sealing material, as appropriate.

5. Wells penetrating water-bearing zones or aquifers of special significance. The enforcing agency may require that specific water-bearing zones be sealed off for well destruction.

C. Placement of Material. The placement of sealing materials for cathodic protection well destruction is generally described in Section 23 and Appendix F of the Water Well Standards. The following additional requirements shall be observed in destroying cathodic protection wells.

Casing, cables, anodes, granular backfill, conductive backfill, and sealing material shall be removed as needed, by redrilling, if necessary, to the point needed to allow proper placement of sealing materials within required sealing intervals. Removal of some or all well materials will likely be required for cathodic protection wells that were not constructed in accordance with
these standards, or standards adopted by the Southern California Cathodic Protection Committee in December 1969.

Casing that cannot be removed shall be adequately perforated or punctured at specific intervals to allow pressure injection of sealing materials into granular backfill and all other voids that require sealing.

The following requirements shall be observed in placing fill and sealing material in cathodic protection wells to be destroyed.

1. **Placement Method.** The well shall be filled and sealed with appropriate material upward from the bottom of the well using a tremie pipe or equivalent.

   Sealing material shall be placed by methods (such as by the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing materials, or separation of aggregates from sealants. Sealing materials shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

2. **Timing of Placement.** Sealing material shall be placed in one continuous operation (or "pour") from the bottom to the top of the well unless conditions in the well dictate that sealing operations be conducted in a staged manner and prior approval is obtained from the enforcing agency.

3. **Ground Water Flow.** Special care shall be used to restrict the flow of ground water into a well while fill and sealing material is being placed, if subsurface pressure causing the flow of water is significant.

4. **Sealing Pressure.** Pressure required for placement of cement-based sealing material shall be maintained long enough for the cement-based sealing material to set.

5. **Verification.** Verification shall be made that the volume of sealing and fill material placed in a well during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determine that the well has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.

D. **Sealing Materials.** Materials used for sealing cathodic protection wells for destruction shall have low permeabilities so that the volume of water and possible pollutants and contaminants passing through them will be of minimal consequence. Sealing material shall be compatible with the chemical environment into which it is placed and shall have mechanical properties compatible with present and future site uses.

Suitable sealing materials include neat cement, sand-cement, concrete, and bentonite, as described in Section 9 of the Water Well Standards. Sealing materials used for isolating zones of fractured rock shall be cement-based, as described in Subsection B, above. Drilling mud or drill cuttings shall not be used as any part of a sealing material for well destruction. Concrete may be used as a sealing material at the approval of the enforcing agency.

E. **Fill Material.** Many fill materials are suitable for destruction of cathodic protection wells. These include clean, washed sand or gravel or sealing material. Fill material shall be free of pollutants and contaminants and shall not be subject to decomposition or consolidation after placement. Fill material shall not contain drilling mud or cuttings.
F. Additional Requirements for Destruction of Cathodic Protection Wells in Urban Areas. The following additional requirements shall be met at each well site in urban areas, unless otherwise approved by the enforcing agency:

(1) The upper surface of the sealing material shall end at a depth of 5 feet below ground surface, and,

(2) If the casing was not extracted during destruction and sealing operations, a hole shall be excavated around the well casing to a depth of 5 feet below ground surface after sealing operations have been completed and sealing materials have adequately set and cured. The exposed well casing shall then be removed by cutting the casing at the bottom of the excavation. The excavation shall then be backfilled with clean, native soil or other suitable material.

G. Temporary Cover. The well borehole and any associated excavations shall be covered at the surface to prevent the entry of foreign material, water, pollutants, and contaminants and to ensure public safety whenever work on the well is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.
APPENDICES
APPENDIX A

Definition of Terms

Protective Anode - A metallic object designed to corrode in place of the object it is designed to protect.

Cathodic Protection\(^1\) - A technique to prevent the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Cement, Portland Cement - A cement that contains oxides of calcium, aluminum, iron, and silicon made by heating a mixture of limestone and clay in a kiln and pulverizing the resultant clinker, as defined in ASTM C150. Portland cement is also considered a hydraulic cement, because it must be mixed with water to form a cement-water paste with the ability to develop strength and harden, even under water.

Centralizer - A device that assists in centering tubular materials in a borehole.

Conductance, Specific - A measure of the ability of water to conduct electric current at 77 degrees Fahrenheit.

Corrosion\(^1\) - The deterioration of a material, usually a metal, because of a reaction with its environment.

Drilling Fluid - A fluid (liquid or gas) used in drilling operations to remove cuttings from a borehole, to clean and cool the drilling bit, to reduce friction between the drill stem and the borehole wall, and, in some cases, to prevent caving or sloughing of the borehole.

Electrolyte\(^1\) - A chemical substance or mixture, usually liquid, containing ions that migrate in an electric field.

The term electrolyte refers to the soil or liquid adjacent to, and in contact with a buried or submerged metallic structure including the moisture and other chemicals contained therein.

Interference\(^1\) - The situation that arises when a foreign substructure is affected in any way by a direct current source.

Rectifier\(^1\) - An electronic device that changes alternating current to direct current.

\(^{1}\) Definition from National Association of Corrosion Engineers Standard RP-01-69 or RP-05-72.
APPENDIX B

REFERENCES

Since Bulletin 74-81 was published in mid-1981 several new or revised publications have been issued that address ground water or well construction. This appendix lists publications issued or revised since 1981 and selected other publications that were reviewed during the preparation of this supplement. Publications that were used for Bulletin 74-81 that have since been revised are identified by a number in parentheses. These numbers refer to the publication’s original position in the bibliography of Bulletin 74-81 (Appendix E, page 83).

Books and Pamphlets


2 American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235, Telephone No.: (303) 794-7711.


Johnson Division, Signal Environmental Systems, Inc. Fletcher P. Driscoll, Principal Author and Editor. *Ground Water and Wells.* 1986. (44)


1 American National Standards Institute.


Periodicals

Civil Engineering. American Society of Civil Engineers. Published monthly since 1930.


Journal of the American Water Works Association. Published monthly since 1920, quarterly between 1914 and 1919.


Western Water. Water Education Foundation. Published monthly since 1949.

Laws, Rules and Regulations

A. Pertinent laws and regulations of the State of California as contained in:
   • California Code of Regulations
   • California Business and Professions Code
   • California Health and Safety Code
   • California Public Resources Code
   • California Water Code

B. The State Water Resources Control Board Model Water Well Ordinance.

C. Existing ordinances of the counties of California pertaining to the construction, alteration, and destruction of wells.

D. Laws, regulations, and recommendations of the various states pertaining to the construction, alteration, or destruction of wells.
Water Quality Control Plan for the Tulare Lake Basin

Board Members
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FOREWORD TO THE SECOND EDITION

Water quality control plans, or basin plans, contain California's administrative policies and procedures for protecting state waters. Basin plans are required by the state Porter-Cologne Water Quality Control Act (California Water Code Section 13240). In addition, Section 303 of the federal Clean Water Act requires states to adopt water quality standards that "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses."

Each of California's nine regional water quality control boards must formulate and adopt a basin plan for all areas within its region. The basin plans must conform with statewide policy set forth by the legislature and by the State Water Resources Control Board. Basin plans consist of designated beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives (California Water Code, Section 13050()).

Beneficial uses, together with their corresponding water quality objectives, meet federal regulatory criteria for water quality standards. Hence, California's basin plans serve as regulatory references for meeting both State and federal requirements for water quality control [40 CFR Parts 130 and 131]. One significant difference between the state and federal programs is that California's basin plans establish standards for ground waters in addition to surface waters.

Basin plans are adopted and amended by regional water boards under a structured process involving full public participation and state environmental review.

Basin plans and amendments do not become effective until approved by the State Water Board. Regulatory provisions must be approved by the Office of Administrative Law. Adoption or revision of surface water standards are subject to the approval of the U.S. Environmental Protection Agency before they become accepted standards for the federal program.

Basin plans complement water quality control plans adopted by the State Water Board. It is the intent of the state and regional water boards to maintain basin plans in an updated and readily available edition that reflects all current water quality control programs.

The first edition of this Water Quality Control Plan for the Tulare Lake Basin (Basin Plan) was adopted by the California Regional Water Quality Control Board, Central Valley Region, on 25 July 1975, and became effective following approval by the State Water Board on 21 August 1975 and the U.S. Environmental Protection Agency (EPA) in June 1976. Although several revisions have been adopted and approved since 1975, this revision is the first complete rewrite of the text of the Basin Plan.

Regional Water Board resolutions adopted prior to 17 August 1995, that revise or supplement the first edition of the plan which are not expressly incorporated by reference into the second edition of the plan are superseded.

In this Basin Plan, "Regional Water Board" refers to the Central Valley Regional Water Quality Control Board and "State Water Board" refers to the State Water Resources Control Board.
I. **INTRODUCTION**

**BASIN DESCRIPTION**

The Central Valley Region includes about 40% of the land in California and stretches from the Oregon border to the Kern County/Los Angeles County line. It is bound by the Sierra Nevada Mountains on the east and the Coast Range on the west. The Region is divided into three basins: the Sacramento River Basin, the San Joaquin River Basin, and the Tulare Lake Basin. This basin plan covers only the Tulare Lake Basin. The Sacramento River Basin and the San Joaquin River Basin are covered in a separate basin plan.

The Tulare Lake Basin comprises the drainage area of the San Joaquin Valley south of the San Joaquin River (See Figure I-1).

Note: In 1976, the U.S. Geologic Survey, the Department of Water Resources, and the State Water Resources Control Board agreed upon the hydrologic boundaries for basins within California. The agreed boundaries did not match the planning boundaries in certain cases such as between the San Joaquin River Basin and the Tulare Lake Basin. The planning boundary between the San Joaquin River Basin and the Tulare Lake Basin follows the northern boundary of Little Panoche Creek basin, continues eastward along the channel of the San Joaquin River to Millerton Lake in the Sierra Nevada foothills, and then follows along the southern boundary of the San Joaquin River drainage basin.

Surface water from the Tulare Lake Basin only drains north into the San Joaquin River in years of extreme rainfall. This essentially closed basin is situated in the topographic horseshoe formed by the Diablo and Temblor Ranges on the west, by the San Emigdio and Tehachapi Mountains on the south, and by the Sierra Nevada Mountains on the east and southeast.

The Basin encompasses approximately 10.5 million acres, of which approximately 3.25 million acres are in federal ownership. Kings Canyon and Sequoia National Parks and substantial portions of Sierra, Sequoia, Inyo, and Los Padres National Forests are included in the Basin. Valley floor lands (i.e., those having a land slope of less than 200 feet per mile) make up slightly less than one-half of the total basin land area. The maximum length and width of the Basin are about 170 miles and 140 miles, respectively. The valley floor is approximately 40 miles in width near its southern end, widening to a maximum of 90 miles near the Kaweah River.

Urban development is generally confined to the foothill and eastern valley floor areas. Major concentrations of population occur in or near the metropolitan areas of Bakersfield, Fresno, Porterville, Hanford, Tulare, and Visalia.

The Basin is one of the most important agricultural centers of the world. Industries related to agriculture, such as food processing and packaging (including canning, drying, and wine making), are prominent throughout the area. Producing and refining petroleum lead non-agricultural industries in economic importance.

Surface water supplies tributary to or imported for use within the Basin are inadequate to support the present level of agricultural and other development. Therefore, groundwater resources within the valley are being mined to provide additional water to supply demands. Water produced in extraction of crude oil is used extensively to supplement agricultural irrigation supply in the Kern River sub-basin.

The Kings, Kaweah, Tule, and Kern Rivers, which drain the west face of the Sierra Nevada Mountains, are of excellent quality and provide the bulk of the surface water supply native to the Basin. Imported surface supplies, which are also of good quality, enter the Basin through the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the Delta-Mendota Canal. Adequate control to protect the quality of these resources is essential, as imported surface water supplies contribute nearly half the increase of salts occurring within the Basin.

Buena Vista Lake and Tulare Lake, natural depressions on the valley floor, receive flood water from the major rivers during times of heavy runoff. During extremely heavy runoff, flood flows in the Kings River reach the San Joaquin River as surface outflow through the Fresno Slough. These flood flows represent the only significant outflows from the Basin.

Besides the main rivers, the basin also contains numerous mountain streams. These streams have been administratively divided into eastside streams and westside streams using Highway 58 from Bakersfield to Tehachapi. Streams from the Tehachapi and San Emigdio Mountains are grouped with westside streams. In contrast to eastside streams, which are fed by Sierra snowmelts and springs from granitic bedrock, westside streams derive from marine sediments and
are highly mineralized, and intermittent, with sustained flows only after extended wet periods.

Surface water hydrologic units within the Tulare Lake Basin have been defined and numbered by the Department of Water Resources, as shown on Figure II-1. Eastside streams are surface waters in hydrologic units 552, 553, 554, and 555. Westside streams are surface waters in hydrologic units 556 and 559 and portions of 541 and 542. Valley floor waters are surface waters in hydrologic units 551, 557, and 558. All natural surface waters within the Basin have designated beneficial uses (See Table II-1).

Normally all native surface water supplies, imported water supplies, and direct precipitation percolate into valley ground water if not lost through consumptive use, evapotranspiration, or evaporation.

Ground water is defined as subsurface water that occurs beneath the ground surface in fully saturated zones within soils and other geologic formations. Where ground water occurs in a saturated geologic unit that contains sufficient permeability and thickness to yield sufficient water to sustain a well or spring, it can be defined as an aquifer (USGS, Water Supply Paper 1988, 1972). A ground water basin is defined as a hydrogeologic unit containing one large aquifer or several connected and interrelated aquifers (Todd, Groundwater Hydrology, 1980).

Major ground water basins underlie the valley floor, and there are scattered smaller basins in the foothill areas and mountain valleys. In many parts of the Basin, usable ground waters occur outside of these identified basins. There are water-bearing geologic units within ground water basins in the Basin that do not meet the definition of an aquifer. Therefore, for basin planning and regulatory purposes, the term "ground water" includes all subsurface waters that occur in fully saturated zones and fractures within soils and other geologic formations, whether or not these waters meet the definition of an aquifer or occur within identified ground water basins.

Generally, the quality and the beneficial uses of the deep ground waters remain the same as before man entered the valley. A few areas within the Basin have ground waters that are naturally unusable or of marginal quality for certain beneficial uses.

Because of the closed nature of the Tulare Lake Basin, there is little subsurface outflow. Thus, salts accumulate within the Basin due to importation and evaporative use of the water. The paramount water quality problem in the Basin is the accumulation of salts. This problem is compounded by the overdraft of ground water for municipal, agricultural, and industrial purposes, and the use of water from deeper formations and outside the basin which further concentrates salts within remaining ground water.

**WASTE DISCHARGE TYPES**

Discharges can be classified as point source or nonpoint source discharges. A point source discharge usually refers to waste emanating from a single, identifiable point. A nonpoint source discharge usually refers to waste emanating from diffused locations. Agricultural runoff may discharge to waters of the state from a pipe, but is treated as a nonpoint source.

Both sources may cause health hazards, contamination, and nuisance problems and both must be managed to reduce salt contributions. Point sources may be high in heavy metals and other toxic materials. Nonpoint source wastes traditionally contribute more dissolved minerals and sediments, but have also contaminated waters with pesticides. Nonpoint source discharges contribute the largest portion of the waste load to surface and ground water resources within the Tulare Lake Basin.

Effective water quality management requires more than control of point source discharges. It must respond to many factors such as water use, land use, social and economic needs, and various other activities within the Basin. Although only a few management actions involve facility construction of some kind, all involve some cost to society. The Regional Water Board has authority to control both categories of discharge, but the approach is less direct for nonpoint sources.

Not fitting either category are spills, leaks, above and under ground storage tanks, and other sites that discharge illegally and impact waters of the state. The Regional Water Board has authority to require investigation and cleanup of these sites.

**Point Sources**

Problems from point source wastes are highly identifiable and for several decades have been subject to regulation. However, they must still be actively managed to protect the state's waters. Regulated point sources include municipal wastewater, oil field wastewater, winery discharges, solid waste sites and other industrial discharges. These dischargers must apply for and obtain waste discharge requirements or a waiver.
Nonpoint Sources

Nonpoint sources include drainage and percolation from a variety of activities, such as agriculture, forestry, recreation, and storm runoff. Specific sources of nonpoint source pollution may be difficult to identify, treat, or regulate. The goal is to reduce the adverse impact of nonpoint source discharges on the Basin's water resources through better management of these activities.

Much of the nonpoint source pollutants originate from agriculture. The Basin's economy is dependent upon agriculture, which is dependent upon water. Water supplies are finite. Some groundwater areas are being overdrafted and additional water is needed to sustain the present intensity of farming. When new lands are put under irrigation, or when cropping patterns are changed, the potential for eliminating overdraft may be lost. Efficient use and development of supplies within the Basin can provide some water to meet growth demands, but to alleviate the projected overdraft, imported water supplies will still be required. The imported water quality should be the highest quality possible to prolong and protect good quality ground water.

Adequate disposal of collected agricultural drainage water from subsurface drains is essential to sustain agriculture in some areas and provide water quality protection. The preferred and long deferred permanent solution of exporting drainage water to San Francisco Bay may not be feasible. In the interim, evaporation ponds are being used for disposal of these saline waters. However, the ponds have created an impact on wildlife that must be mitigated for this interim disposal option to remain viable.

Salinity increases in ground water can ultimately eliminate the beneficial use of the resource. This loss will not be immediate, but control of the increase is a major part of this plan. Salt loads reaching the ground water body must be reduced. Storage of salt in the soil through increased irrigation efficiency is being done, but is only a temporary solution. Current fertilization and soil amendment practices should be reviewed. Methods to control the leachate from newly developed lands should be studied.

Watersheds must be managed to protect water quality. This can be accomplished within the concept of multiple uses of resources. Esthetic, recreational, wildlife, and other uses should receive consideration. Two historical problems within the Tulare Lake Basin are poor sanitation associated with recreational use and erosion from construction, logging, grazing, and irrigated agriculture. Management of these activities has improved the situation and must continue to assure no significant adverse effect on pristine streams. Erodible material must be stabilized so that turbidity in streams will be of limited intensity and duration. Activities in stream protection zones must be regulated. Provisions should be made to protect fishery flow releases in designated reaches of streams.

Waste disposal from land developments and from animals in confinement must conform with guidelines. Most existing unsewered communities need not be sewered if individual waste systems are properly sited, operated and maintained. New developments must consider collection systems and should connect if within the sphere of influence of an established collection and treatment system. Septic tank pumpings must be treated and disposed of in a way that prevents impact to waters of the state.
FIGURE I-1
REGIONAL WATER QUALITY CONTROL BOARDS
TULARE LAKE BASIN LOCATION MAP

1. North Coast Region
2. San Francisco Bay Region
3. Central Coast Region
4. Los Angeles Region
5. Central Valley Region
6. Lahontan Region
7. Colorado River Basin Region
8. Santa Ana Region
9. San Diego Region

Tulare Lake Basin
II. EXISTING AND POTENTIAL BENEFICIAL USES

Protection and enhancement of beneficial uses of water against quality degradation is a basic requirement of water quality planning under the Porter-Cologne Water Quality Control Act. In setting water quality objectives, the Regional Water Board must consider past, present, and probable future beneficial uses of water.

Significant points concerning beneficial uses are:

1. All water related problems can be stated in terms of whether there is water of sufficient quantity and quality to protect or enhance beneficial uses.

2. Fish, plants, and other wildlife, as well as humans, depend on and use water beneficially both directly or indirectly.

3. Defined beneficial uses do not include all possible uses of water. For example, use of waters for disposal of wastewaters is not included as a beneficial use. Similarly, the use of water for the dilution of salts in other waters is not a beneficial use. These may, in some cases, be reasonable and desirable uses of water, but they are not protected uses and are subject to regulation as activities that may harm protected uses.

4. The protection and enhancement of beneficial uses requires that certain quality and quantity objectives be met for surface and ground waters.

5. Quality of water in upstream reaches and upper aquifers may impact the quality and beneficial uses of downstream reaches and lower aquifers.

Beneficial use designations (and water quality objectives, see Chapter III) must be reviewed at least once during each three-year period for potential modification as appropriate (40 CFR Part 131.20).

The beneficial uses and abbreviations as defined and listed below are the standard designations used in all basin plans in California with the exception of the definition for Fish Spawning (SPWN) and Warm Freshwater Habitat (WARM). The standard statewide definition for SPWN includes spawning of both warm and cold water fish. In the Tulare Lake Basin, warm water spawning is considered to occur wherever a warm freshwater habitat exists while only select cold water habitats are suitable for spawning by cold water species. For example, certain cold water species require gravel beds in order to spawn. For this reason, for the Tulare Lake Basin, SPWN has been modified to limit the designation to suitable reaches of cold water streams and WARM has been modified to clarify that it includes sensitive fish propagation stages.

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems, including, but not limited to, drinking water supply.

Agricultural Supply (AGR) - Uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality, including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Industrial Process Supply (PRO) - Uses of water for industrial activities that depend primarily on water quality.

Hydropower Generation (POW) - Uses of water for hydropower generation.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiling, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-Contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sun-bathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Warm Freshwater Habitat (WARM) - Uses of water that support warm water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

WARM includes support for reproduction and early development of warm water fish.

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Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Wildlife Habitat (WILD) - Uses of water that support terrestrial or wetland ecosystems, including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Spawning, Reproduction, and / or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

SPWN shall be limited to cold water fisheries.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality.

Aquaculture (AQUA) - Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Preservation of Biological Habitats of Special Significance (BIOL) - Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

The existing and probable future beneficial uses which currently apply to surface waters are presented in Figure II-1 and Table II-1. The beneficial uses of any specifically identified water body generally apply to its tributary streams. In some cases a beneficial use may not be applicable to the entire body of water. In these cases the Regional Water Board's judgement will be applied. It should be noted that it is impractical to list every surface water body in the Region. For unidentified water bodies, the beneficial uses will be evaluated on a case-by-case basis.

Upstream from the foothill reservoirs, the quality of surface waters remains good to excellent. The quality of the major streams is suitable for all beneficial uses. Beneficial uses below the dams, however, may be significantly impacted because of the reduced flows in the channels.

For ground water, the following beneficial uses have been identified and occur throughout the Basin:
- Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), Industrial Service Supply (IND), Industrial Process Supply (PRO), Water Contact Recreation (REC-1), and Wildlife Habitat (WILD).

Figure II-2 and Table II-2 present the AGR, IND, PRO, REC-1, REC-2, and WILD beneficial uses of ground water that existed as of 1993. Due to the "Sources of Drinking Water Policy," all ground waters are designated MUN (the use may be existing or potential) unless specifically exempted by the Regional Water Board and approved for exemption by the State Water Board. Ground water areas exempted from MUN are footnoted in Table II-2. In addition, unless otherwise designated by the Regional Water Board, all ground waters in the Region are considered suitable or potentially suitable, at a minimum, for agricultural supply (AGR), industrial supply (IND), and industrial process supply (PRO).

Existing beneficial uses generally apply within the listed Detailed Analysis Unit (DAU). Due to the size of the DAUs, however, the listed uses may not exist throughout the DAU. For the purpose of assigning beneficial uses, the term ground water is defined in Chapter I.

In considering any exceptions to the beneficial use designation of MUN, the Regional Water Board employs the following criteria:
1. The TDS must exceed 3,000 mg/l (5,000 μmhos/cm EC) and the aquifer cannot be reasonably expected to supply a public water system, or

2. There is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices, or

3. The water source cannot provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day, or

4. The aquifer is regulated as a geothermal energy producing source or has been exempted administratively pursuant to 40 CFR, Section 146.4 for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy, provided that these fluids do not constitute a hazardous waste under 40 CFR, Section 261.3.

In making any exceptions to the beneficial use designation of industrial supply (IND or PRO), the Regional Water Board will consider the following criteria:

1. There is pollution, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for agricultural use using either Best Management Practices or best economically achievable treatment practices, or

2. The water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day.

To be consistent with State Water Board Resolution No. 88-63 in making exceptions to beneficial use designations other than municipal and domestic supply (MUN), the Regional Water Board will consider criteria for exceptions, parallel to Resolution No. 88-63 exception criteria, which would indicate limitations on those other beneficial uses as follows:

In making any exceptions to the beneficial use designation of agricultural supply (AGR), the Regional Water Board will consider the following criteria:
<table>
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<th>MUN</th>
<th>AGR</th>
<th>IND</th>
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<th>POW</th>
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<th>REC-2</th>
<th>WARM</th>
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* Table II-2 presents the AGR, IND, PRO, REC-1, REC-2, and WILD beneficial uses of ground water that existed as of 1993.
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GROUND WATER BENEFICIAL USES* (continued)

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TABLE II-2
TULARE LAKE BASIN
GROUND WATER BENEFICIAL USES (continued)
Beneficial Use Exceptions

- Ground water contained in the lower Transition Zone and Santa Margarita formation within 3,000 feet of the Kern Oil and Refining Company proposed injection wells in Section 25, T30S, R28E, MDB&M, is not suitable, or potentially suitable, for municipal or domestic supply (MUN).

Ground water contained in the basal Etchegoin formation, Chumac formation, and Santa Margarita formation within, and extending to one-quarter mile outside the administrative boundary of the Fruitvale Oil Field, as defined by the State of California, Department of Conservation, Division of Oil and Gas in Application for Primacy in the Regulation of Class II Injection Wells Under Section 1425 of the Safe Drinking Water Act, dated April 1981, is not suitable, or potentially suitable, for municipal or domestic supply (MUN). However, the upper ground water zone (ground water to a depth of 3,000 feet) retains the MUN beneficial use.

- Ground water and spring water within 1/2 mile radius of the McKittrick Waste Treatment (formerly Liquid Waste Management) site in Section 29, T30S, R22E, MDB&M, have no beneficial uses.

- Ground water in the San Joaquin, Etchegoin, and Jacalitos Formations within one-half mile of existing surface impoundments P-1, P-2, P-3, P-4 1/2, P-5, P-6, P-7, P-8, P-9, P-10, P-11, P-12/12A, P-13, P-14, P-15, P-16, P-17, P-18, P-19, and P-20, and proposed surface impoundments P-21, P-24, P-25, P-27, P-28, and P-29 at the Kettleman Hills Facility (Sections 33 and 34, T22S, R18E, and Section 3, T23S, R18E, MDB&M) of Chemical Waste Management is not a municipal or domestic supply (MUN).
Figures II-1 and II-2 will be included at 1:500,000 scale in map pockets in back of final plan.
III. WATER QUALITY OBJECTIVES

The Porter-Cologne Water Quality Control Act defines water quality objectives as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" [Water Code Section 13050(h)]. It also requires the Regional Water Board to establish water quality objectives, while acknowledging that it is possible for water quality to be changed to some degree without unreasonably affecting beneficial uses. In establishing water quality objectives, the Regional Water Board must consider, among other things, the following factors:

- Past, present, and probable future beneficial uses;
- Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereon;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region;
- The need to develop and use recycled water. [Water Code Section 13241]

The federal Clean Water Act requires a state to submit for approval of the Administrator of the U.S. Environmental Protection Agency (USEPA) all new or revised water quality standards which are established for surface and ocean water. The ground water objectives contained in this plan are not required by the federal Clean Water Act. In California, water quality standards are either water body specific or are based on beneficial uses designated for a water body and the water quality objectives that protect those uses.

There are six important points about water quality objectives. The first point is that water quality objectives can be revised through the basin plan amendment process. Objectives may apply region-wide or specifically to individual water bodies or parts of water bodies. Site-specific objectives may be developed if the Regional Water Board believes they are appropriate. Federal regulations require the review of water quality standards at least every three years. These "Triennial Reviews" provide one opportunity to evaluate the effectiveness of existing water quality objectives because the reviews begin with an identification of potential and actual water quality problems. The results of the Triennial Review are used to identify and prioritize Regional Water Board actions to achieve objectives and protect beneficial uses. Actions include assessment, remediation, monitoring, or whatever else may be appropriate, to address water quality problems. For example, a beneficial use may be impacted because the existing water quality objective is inadequate. This water quality objective should be re-evaluated and a proper objective should be amended into the Basin Plan, along with a plan and schedule for attainment. In other cases, the existing water quality objective may be adequate and it may be necessary to develop new implementation strategies to address the problem.

Changes to a water quality objective can also occur because of new scientific information on the effects of a pollutant on beneficial uses. A major source of information is USEPA data on the effects of chemical and other constituent concentrations on particular aquatic species and human health. Other common information sources for data on protection of beneficial uses include the National Academy of Science, which has published data on bioaccumulation, and the federal Food and Drug Administration, which has issued criteria for unacceptable levels of chemicals in fish and shellfish used for human consumption. The Regional Water Board may also make use of other state or federal agency information sources when assessing new or revised water quality objectives.

The second point is that achievement of water quality objectives depends on applying them to regulate controllable water quality factors, although regulating controllable water quality factors may not necessarily cause water quality objectives to be achieved. Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Water Board or the Regional Water Board, and that may be reasonably controlled. These factors are subject to the authority of the State Water Board or the Regional Water Board. Controllable factors are not allowed to degrade water quality unless it is demonstrated that degradation is consistent with maximum benefit to the people of the State. In no cases may controllable water quality factors unnecessarily affect present and anticipated beneficial uses of water nor result in water quality less than that prescribed in water quality control plans and policies. In instances where uncontrollable factors have already resulted in
water quality objectives being exceeded, controllable factors are not allowed to cause further degradation of water quality. The Regional Water Board recognizes that manmade changes that alter flow regimes can affect water quality and impact beneficial uses.

The third point is that water quality objectives are achieved primarily through the adoption of waste discharge requirements (including federal NPDES permits) and enforcement orders. When adopting requirements and ordering actions, the Regional Water Board considers the beneficial uses within the area of influence of the discharge, the existing quality of receiving waters, and water quality objectives that apply to the reach or uses of the receiving water. Effluent limits may be established to reflect what is necessary to achieve water quality objectives, or, if more stringent, will reflect the technology-based standard for the type of discharge being regulated. The objectives in this plan do not require improvement over naturally occurring background concentrations. Water quality objectives contained in this plan, and any State or Federally promulgated objectives applicable to the Tulare Lake Basin, apply to the main water mass. They may apply at or in the immediate vicinity of effluent discharges, or may apply at the edge of an approved mixing zone. A mixing zone is an area of dilution or criteria for diffusion or dispersion defined in the waste discharge requirements. The Regional Water Board recognizes that immediate compliance with water quality objectives adopted by the Regional Water Board or the State Water Board, or with water quality criteria adopted by the federal Environmental Protection Agency, may not be feasible in all circumstances. Where the Regional Water Board determines it is infeasible for a discharger to comply immediately with such objectives or criteria, compliance shall be achieved in the shortest practicable period of time, not to exceed ten years after the adoption of applicable objectives or criteria. This policy shall apply to water quality objectives and water quality criteria adopted after the effective date of this Basin Plan update.

The fourth point is that, in cases where water quality objectives are formulated to preserve historic conditions, there may be insufficient data to determine completely the temporal and hydrologic variability representative of historic water quality. When violations of such water quality objectives occur, the Regional Water Board evaluates the reasonableness of achieving those objectives through regulation of the controllable factors in the areas of concern.

The fifth point is that the State Water Board adopts policies and plans for water quality control that can specify water quality objectives or affect their implementation. Chief among the State Water Board’s policies for water quality control is State Water Board Resolution No. 68-16, Statement of Policy with Respect to Maintaining High Quality of Waters in California (Anti-degradation Policy). It requires that, wherever the existing quality of surface or ground waters is better than the objectives established for those waters, the existing quality will be maintained unless as otherwise provided by Resolution No. 68-16 or any revisions thereto. This policy and others establish general objectives.

The sixth point is that water quality objectives may be in numerical or narrative form. The enumerated milligram-per-liter (mg/l) limit for dissolved oxygen is an example of a numerical objective; the objective for color is an example of a narrative objective.

**WATER QUALITY OBJECTIVES FOR INLAND SURFACE WATERS**

Surface water quality in the Basin is generally good, with excellent quality exhibited by most eastside streams. The Regional Water Board intends to maintain this quality. The water quality objectives below are presented by categories which, like the beneficial uses of Chapter II, were standardized for uniformity among the regional water boards. Designated beneficial uses of the waters of the Tulare Lake Basin for which provisions should be made are identified in Chapter II; this chapter gives the water quality objectives to protect those beneficial uses. As new information becomes available, the Regional Water Board will review the appropriateness of these objectives, and may modify them accordingly.

**Ammonia**

Waters shall not contain un-ionized ammonia in amounts which adversely affect beneficial uses. In no case shall the discharge of wastes cause concentrations of un-ionized ammonia (NH₃) to exceed 0.025 mg/l (as N) in receiving waters.

**Bacteria**

In waters designated REC-1, the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 ml.

**Biostimulatory Substances**

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the
extent that such growths cause nuisance or adversely affect beneficial uses.

**Chemical Constituents**

Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. The Regional Water Board will consider all material and relevant information submitted by the discharger and other interested parties and guidelines developed by the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the U.S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective.

At a minimum, water designated MUN shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Table 64449-A (Secondary Maximum Contaminant Levels-Consumer Acceptance Levels) and 64449-B (Secondary Maximum Contaminant Levels-Ranges) of Section 64449. This incorporation by reference is prospective, including any changes to the incorporated provisions as the changes take effect. At a minimum, water designated MUN shall not contain lead in excess of 0.015 mg/l. The Regional Water Board acknowledges that specific treatment requirements are imposed by state and federal drinking water regulations on the consumption of surface waters under specific circumstances. To ensure that waters do not contain chemical constituents in concentrations that adversely affect beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

**Color**

Waters shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

**Dissolved Oxygen**

Waste discharges shall not cause the monthly median dissolved oxygen concentrations (DO) in the main water mass (at centroid of flow) of streams and above the thermocline in lakes to fall below 85 percent of saturation concentration, and the 95 percentile concentration to fall below 75 percent of saturation concentration.

The DO in surface waters shall always meet or exceed the concentrations in Table III-1 for the listed specific water bodies and the following minimum levels for all aquatic life:

- Waters designated WARM 5.0 mg/l
- Waters designated COLD or SPWN 7.0 mg/l

Where ambient DO is less than these objectives, discharges shall not cause a further decrease in DO concentrations.

**Floating Material**

Waters shall not contain floating material, including but not limited to solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

**Oil and Grease**

Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

**pH**

The pH of water shall not be depressed below 6.5, raised above 8.3, or changed at any time more than 0.3 units from normal ambient pH.

In determining compliance with the above limits, the Regional Water Board may prescribe appropriate averaging periods provided that beneficial uses will be fully protected.

**Pesticides**

Waters shall not contain pesticides in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses. (For the purposes of this objective, the term pesticide is defined as any substance or mixture of substances used to control objectionable insects, weeds, rodents, fungi, or other forms of plant or animal life.) The Regional Water Board will consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for detrimental levels of chemical constituents developed by the State Water Board.
TABLE III-1
TULARE LAKE BASIN
SPECIFIC DISSOLVED OXYGEN WATER QUALITY OBJECTIVES

<table>
<thead>
<tr>
<th>Stream</th>
<th>Location</th>
<th>Min DO (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kings River</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Kirch Flat</td>
<td>9</td>
</tr>
<tr>
<td>Reach II</td>
<td>Kirch Flat to Pine Flat Dam</td>
<td>9</td>
</tr>
<tr>
<td>Reach III</td>
<td>Pine Flat Dam to Friant-Kern</td>
<td>9</td>
</tr>
<tr>
<td>Reach IV</td>
<td>Friant-Kern to Peoples Weir</td>
<td>7</td>
</tr>
<tr>
<td>Reach V</td>
<td>Peoples Weir to Island Weir</td>
<td>7</td>
</tr>
<tr>
<td>Kaweah River</td>
<td>Lake Kaweah</td>
<td>7</td>
</tr>
<tr>
<td>Tule River</td>
<td>Lake Success</td>
<td>7</td>
</tr>
<tr>
<td>Kern River</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Lake Isabella</td>
<td>8</td>
</tr>
<tr>
<td>Reach III</td>
<td>Lake Isabella to Southern California Edison Powerhouse (KR-1)</td>
<td>8</td>
</tr>
</tbody>
</table>

Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U. S. Food and Drug Administration, the National Academy of Sciences, the U. S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective.

At a minimum, waters designated MUN shall not contain concentrations of pesticide constituents in excess of the maximum contaminant levels (MCLs) specified in Table 64444-A (Organic Chemicals) of Section 64444 of Title 22 of the California Code of Regulations, which is incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. The Regional Water Board acknowledges that specific treatment requirements are imposed by state and federal drinking water regulations on the consumption of surface waters under specific circumstances. To ensure that waters do not contain chemical constituents in concentrations that adversely affect beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

In waters designated COLD, total identifiable chlorinated hydrocarbon pesticides shall not be present at concentrations detectable within the accuracy of analytical methods prescribed in Standard Methods for the Examination of Water and Wastewater, 18th Edition, or other equivalent methods approved by the Executive Officer.

Radioactivity

Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life nor which result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

At a minimum, waters designated MUN shall not contain concentrations of radionuclides in excess of the maximum contaminant levels (MCLs) specified in Table 4 (MCL Radioactivity) of Section 64443 of Title 22, California Code of Regulations, which are incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Salinity

Waters shall be maintained as close to natural concentrations of dissolved matter as is reasonable considering careful use of the water resources.

"The only reliable way to determine the true or absolute salinity of a natural water is to make a complete chemical analysis. However, this method is time-consuming and cannot yield the precision necessary for accurate work" [Standard Methods for the Examination of Water and Wastewater, 18th Edition]. Conductivity is one of the recommended methods to determine salinity.
The objectives for electrical conductivity in Table III-2 apply to the water bodies specified. Table III-3 specifies objectives for electrical conductivity at selected streamflow stations.

**Sediment**

The suspended sediment load and suspended sediment discharge rate of waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

**Settleable Material**

Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

**TABLE III-2**

**TULARE LAKE BASIN**

**MAXIMUM ELECTRICAL CONDUCTIVITY LEVELS**

<table>
<thead>
<tr>
<th>Stream</th>
<th>Location</th>
<th>Max. Electrical Conductivity (μmhos/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kings River</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Kirch Flat</td>
<td>100</td>
</tr>
<tr>
<td>Reach II</td>
<td>Kirch Flat to Pine Flat Dam</td>
<td>100*</td>
</tr>
<tr>
<td>Reach III</td>
<td>Pine Flat Dam to Friant-Kern</td>
<td>100</td>
</tr>
<tr>
<td>Reach IV</td>
<td>Friant-Kern to Peoples Weir</td>
<td>200</td>
</tr>
<tr>
<td>Reach V</td>
<td>Peoples Weir to Island Weir</td>
<td>300*</td>
</tr>
<tr>
<td>Reach VI</td>
<td>Island Weir to Stinson Weir on North Fork</td>
<td>300*</td>
</tr>
<tr>
<td></td>
<td>and Empire Weir No. 2 on South Fork</td>
<td></td>
</tr>
<tr>
<td><strong>Kaweah River</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Lake Kaweah</td>
<td>175</td>
</tr>
<tr>
<td>Reach II</td>
<td>Lake Kaweah</td>
<td>175*</td>
</tr>
<tr>
<td>Reach III</td>
<td>Below Lake Kaweah</td>
<td></td>
</tr>
<tr>
<td><strong>Tule River</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Lake Success</td>
<td>450</td>
</tr>
<tr>
<td>Reach II</td>
<td>Lake Success</td>
<td>450*</td>
</tr>
<tr>
<td>Reach III</td>
<td>Below Lake Success</td>
<td></td>
</tr>
<tr>
<td><strong>Kern River</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach I</td>
<td>Above Lake Isabella</td>
<td>200</td>
</tr>
<tr>
<td>Reach II</td>
<td>Lake Isabella</td>
<td>300</td>
</tr>
<tr>
<td>Reach III</td>
<td>Lake Isabella to Southern California Edison Powerhouse (KR-1)</td>
<td>300*</td>
</tr>
<tr>
<td>Reach IV</td>
<td>KR-1 to Bakersfield</td>
<td>300*</td>
</tr>
<tr>
<td>Reach V</td>
<td>Below Bakersfield</td>
<td></td>
</tr>
</tbody>
</table>

* Maximum 10-year average - 50 μmhos

* During the period of irrigation deliveries. Providing, further, that for 10 percent of the time (period of low flow) the following shall apply to the following reaches of the Kings River:

  Reach V  400 μmhos
  Reach VI 600 μmhos

* Maximum 10-year average - 100 μmhos

* During the irrigation season releases should meet the levels shown in the preceding reach. At other times the channel will be dry or controlled by storm flows.

* Maximum 10-year average - 250 μmhos

* Maximum 10-year average - 175 μmhos
### TABLE III-3
TULARE LAKE BASIN
ELECTRICAL CONDUCTIVITY OBJECTIVES AT SELECTED STREAMFLOW STATIONS

<table>
<thead>
<tr>
<th>Streamflow Station Number</th>
<th>Location</th>
<th>Electrical Conductivity (microsiemens/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USGS</td>
<td>DWR</td>
<td>90-Percentile</td>
</tr>
<tr>
<td>11-2185</td>
<td>C01140.00 Kings River below Peoples Weir</td>
<td>198</td>
</tr>
<tr>
<td>11-2215</td>
<td>C11460.00 Kings River below North Fork</td>
<td>68</td>
</tr>
<tr>
<td>11-2105</td>
<td>C11140.00 Kings River below Pine Flat Dam</td>
<td>54</td>
</tr>
<tr>
<td>11-2032</td>
<td>C21250.00 Kaweah River near Three Rivers</td>
<td>154</td>
</tr>
<tr>
<td>11-2049</td>
<td>C31150.00 Tule River near Springville</td>
<td>429</td>
</tr>
<tr>
<td>11-1870</td>
<td>C03195.00 Tule River below Success Dam</td>
<td>368</td>
</tr>
<tr>
<td>11-1910</td>
<td>C51500.00 Kern River at Kernville</td>
<td>177</td>
</tr>
<tr>
<td>11-1940</td>
<td>C05150.00 Kern River below Isabella Dam</td>
<td>278</td>
</tr>
</tbody>
</table>

Suspended Material

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

Tastes and Odors

Waters shall not contain taste- or odor-producing substances in concentrations that cause nuisance, adversely affect beneficial uses, or impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin or to domestic or municipal water supplies.

Temperature

Natural temperatures of waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the Water Quality Control Plan for Control of Temperature in the Coastal and Interior Waters and Enclosed Bays of California, including any revisions. (See Appendix 10.)

Elevated temperature wastes shall not cause the temperature of waters designated COLD or WARM to increase by more than 5°F above natural receiving water temperature.

In determining compliance with the above limits, the Regional Water Board may prescribe appropriate averaging periods provided that beneficial uses will be fully protected.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, biotoxicity tests of appropriate duration, or other methods as specified by the Regional Water Board. The Regional Water Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the U.S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective.

The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors shall not be less than that for the same water body in areas unaffected by the waste discharge, or, when necessary, for other control water that is
consistent with the requirements for "dilution water" as described in Standard Methods for the Examination of Water and Wastewater, 18th Edition. As a minimum, compliance shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon acute biotoxicity tests of effluents will be prescribed where appropriate; additional numerical receiving water quality objectives for specific toxicants will be established as sufficient data become available; and source control of toxic substances will be encouraged.

**Turbidity**

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU.
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.
- Where natural turbidity is equal to or between 50 and 100 NTUs, increases shall not exceed 10 NTUs.
- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

In determining compliance with the above limits, the Regional Water Board may prescribe appropriate averaging periods provided that beneficial uses will be fully protected.

**WATER QUALITY OBJECTIVES FOR GROUND WATERS**

The following objectives apply to all ground waters in the Tulare Lake Basin.

**Bacteria**

In ground waters designated MUN, the concentration of total coliform organisms over any 7-day period shall be less than 2.2/100 ml.

**Chemical Constituents**

Ground waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. The Regional Water Board will consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for detrimental levels of chemical constituents developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U. S. Food and Drug Administration, the National Academy of Sciences, the U. S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective.

At a minimum, waters designated MUN shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B (Fluoride) of Section 64431, Table 64444-A (Organic Chemicals) of Section 64444, and Table 64449-A (Secondary Maximum Contaminant Levels-Consumer Acceptance Limits) and 64449-B (Secondary Maximum Contaminant Levels-Ranges) of Section 64449. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. At a minimum, water designated MUN shall not contain lead in excess of 0.015 mg/l. To ensure that waters do not contain chemical constituents in concentrations that adversely affect beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

**Pesticides**

No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses.

At a minimum, waters designated MUN shall not contain concentrations of pesticide constituents in excess of the maximum contaminant levels (MCLs) specified in Table 64444-A (Organic Chemicals) of Section 64444 of Title 22 of the California Code of Regulations, which is incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. The Regional Water Board acknowledges that specific treatment requirements are imposed by state and federal drinking water regulations on the consumption of surface waters under specific circumstances. More stringent objectives may apply if necessary to protect other beneficial uses.

**Radioactivity**

Radionuclides shall not be present in ground waters in concentrations that are deleterious to human, plant,
animal, or aquatic life, or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal or aquatic life.

At a minimum, ground waters designated MUN shall not contain concentrations of radionuclides in excess of the maximum contaminant levels (MCLs) specified in Table 4 (MCL Radioactivity) of Section 64443 of Title 22, California Code of Regulations, which are incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

**Salinity**

All ground waters shall be maintained as close to natural concentrations of dissolved matter as is reasonable considering careful use and management of water resources.

No proven means exist at present that will allow ongoing human activity in the Basin and maintain ground water salinity at current levels throughout the Basin. Accordingly, the water quality objectives for ground water salinity control the rate of increase.

The maximum average annual increase in salinity measured as electrical conductivity shall not exceed the values specified in Table III-4 for each hydrographic unit shown on Figure III-1.

The average annual increase in electrical conductivity will be determined from monitoring data by calculation of a cumulative average annual increase over a 5-year period.

**Tastes and Odors**

Ground waters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

**Toxicity**

Ground waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life associated with designated beneficial use(s). The Regional Water Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U. S. Food and Drug Administration, the National Academy of Sciences, the U. S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances.

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**TABLE III-4**

**TULARE LAKE BASIN**

**GROUND WATER QUALITY OBJECTIVES FOR SALINITY**

<table>
<thead>
<tr>
<th>Hydrographic Unit</th>
<th>Maximum Average Annual Increase in Electrical Conductivity (µS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westside (North and South)</td>
<td>1</td>
</tr>
<tr>
<td>Kings River</td>
<td>4</td>
</tr>
<tr>
<td>Tulare Lake and Kaweah River</td>
<td>3</td>
</tr>
<tr>
<td>Tule River and Poso</td>
<td>6</td>
</tr>
<tr>
<td>Kern River</td>
<td>5</td>
</tr>
</tbody>
</table>

III-8

17 August 1995

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FIGURE III-1

TULARE LAKE BASIN
GROUND WATER HYDROGRAPHIC UNITS
IV. IMPLEMENTATION PLAN

Our knowledge of the number and types of problems associated with discharge activities changes over time. Early federal and state control efforts focused on the most understood and visible problems, such as discharge of raw sewage to rivers and streams. As these problems were controlled, focus shifted to prevention of nuisance and protection of ground water. As data became available on toxics in the environment and their harmful effects at low concentrations, and as toxic pollutant detection and measurement methods improved, regulatory emphasis shifted further. Control of toxic discharges now receives major emphasis. Small amounts of pesticides in drinking water wells within the Tulare Lake Basin have caused the closure of some wells.

The greatest long-term problem facing the entire Tulare Lake Basin is the increase of salinity in ground water. Even though an increase in the salinity of ground water in a closed basin is a natural phenomenon, salinity increases in the Basin have been accelerated by man's activity, with the major impact coming from intensive use of soil and water resources by irrigated agriculture. Salinity increases in ground water could ultimately eliminate the beneficial uses of this resource. Controlled ground water degradation by salinity is the most feasible and practical short-term management alternative for the Tulare Lake Basin.

The following briefly describes the water quality impacts associated with specific discharge activities and the policies and programs developed to protect beneficial uses and achieve water quality objectives.

Agriculture

In 1987, agriculturally induced employment in the Basin ranged from 20 percent to more than 50 percent ["A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley", September 1990]. Most of the agricultural activity occurs on the valley floor. However, the natural precipitation on the Valley portion of the Basin averages less than 10 inches per year. Most precipitation occurs in the Sierras and the Coast Ranges. In order to supply the water needs of agriculture, water from the mountain areas is held in reservoirs and released during irrigation periods. The released water is transported to crops through a complex distribution system crisscrossing the Valley. Irrigated agriculture, agricultural support activities, and animal confinement operations create their own unique problems.
Irrigated Agriculture

Irrigated agriculture accounts for most water used in the Tulare Lake Basin. Local surface water, mainly stored in foothill reservoirs, is controlled for agricultural use. Historically, ground water made up the rest of agricultural needs. However, heavy ground water extractions after the 1930s, when improvements in pump technology led to the development of large turbine pumps, caused severe overdraft and accompanying land subsidence. This led to development of water projects (i.e., the California Aqueduct, the Delta-Mendota Canal, the Friant-Kern Canal, and the Cross City Canal) in the 1950’s, 1960’s and 1970’s to import additional water into the Basin to relieve the demands on ground water. Even with the imported water, municipal, agricultural, and industrial water users continue to pump ground water to meet demands. Ground water pumping continues to contribute to overdraft of ground water aquifers.

Another problem from irrigated agriculture is drainage, excess water not used by crops which runs off or percolates. Agricultural drainage, depending on management and location, carries varying amounts of salts, nutrients, pesticides, trace elements, sediments, and other products to surface and ground waters.

The crucial problem in the Tulare Lake Basin is the salts brought in with irrigation water and leached out of soils. Evaporation and crop transpiration remove water from soils, which can result in an accumulation of salts in the root zone of the soils at levels that retard or inhibit plant growth. Additional amounts of water are often applied to leach the salts below the root zone. The leached salts eventually enter ground or surface water.

The amount of salts which are leached depends on the amounts in the soil profile and the applied waters. In 1970, the Department of Water Resources estimated that 481 million tons of salt were stored in the top 20 feet of soil (or the root zone) in the San Joaquin Valley (Department of Water Resources, “Land and Water Use Aspects of San Joaquin Valley Drainage Investigations”, June 1970). In 1971, the Department of Water Resources estimated that the four major rivers of the Tulare Lake Basin bring in 145,000 tons of salt per year. Another 63,000 tons are brought in by the Friant-Kern Canal, annually. The Delta-Mendota Canal brings in 336,000 tons per year (Department of Water Resources, “A General Survey of Electrical Conductivity in Ground Water, San Joaquin Valley”, March through June 1971).

The movement of the salts to surface waters can occur as shallow subsurface ground water flows or it can result from the surface water discharge of agricultural subsurface collection systems (or tile drains) which are employed in areas where farm lands have naturally poor drainage. Tile drains consist of pipe systems below the root zone of crops that drain water from soils that would otherwise stay saturated. TDS concentrations in tile drained water is many times greater than in the irrigation water that was applied to the crops. Tile drain water can also contain trace elements and nutrients. Removal and export, through a valleywide drain, of perched waters will offset, in part, the Basin’s adverse salt accumulation.

Subsurface drainage will be a constant threat to surface water and usable ground water quality unless the disposal method is adequate. Disposal must be in a manner that isolates the salts in the drainage from the usable ground water body. In some areas of the Basin, evaporation basins are used to concentrate drainage water and contain salts. However, evaporation basins cannot be considered permanent solutions due to wildlife impacts, and the cost of ultimate salt disposal and basin closure. The California Department of Water Resources and other federal, state and local agencies continue to study alternative approaches for reuse and disposal of agricultural drainage waters.

The Central Valley provides critically important wetland habitat for wintering waterfowl of the Pacific Flyway. The Pacific Flyway covers the western portion of the North American Continent. Most Pacific Flyway waterfowl are from the prairies and parklands of western Canada and the river valleys and deltas of Alaska. The Central Valley supports approximately 60% of the Pacific Flyway wintering waterfowl population. Hundreds of thousands of shorebirds and other water or marsh birds annually winter or pass through the Central Valley [San Joaquin Valley Drainage Program, “Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California”, Volume I, October 1990].

Evaporation ponds constitute attractive oases for many species of wildlife. Aquatic migratory birds of the Pacific Flyway are drawn to the ponds, in part, because almost all of the native aquatic and wetland habitats in the San Joaquin Valley (especially in the Tulare Lake Basin) have been lost and because the ponds hold surface water in a vast, relatively sterile, agricultural landscape. The ponds also produce abundant aquatic invertebrates which feed large numbers of waterbirds [San Joaquin Valley Drainage...]

IV-2 17 August 1995
Evaporation basins have varying potentials to impact wildlife, specifically shorebirds. Various studies have been conducted on this impact. Technical reports addressing site-specific and cumulative impacts from the majority of operating basins were completed in 1993. These reports were certified as environmental impact reports (EIRs).

The EIRs focussed on impacts to wildlife and found all basins pose a risk to birds due to salinity and avian disease. To prevent and mitigate these impacts, waste discharge requirements for evaporation basins, adopted in 1993, include the following:

- Removal of attractive habitat, such as vegetation.
- A program for avian and waterfowl disease prevention, surveillance and control.
- Closure and financial assurance plans.
- Drainage operation plan to reduce drainage.

Basins with concentrations of selenium greater than 2.7 μg/l in the drainage water have potential for reduced hatchability and teratogenic impacts on waterfowl. To prevent and mitigate these impacts, waste discharge requirements for these basins, adopted in 1993, include those listed above and the following:

- Intensive hazing prior to the breeding season.
- Egg monitoring.
- Basin reconfiguration, if necessary, to minimize attractiveness to waterbirds.
- Wildlife enhancement program, alternative habitat and/or compensatory habitat.

Regional Water Board policy on agricultural subsurface drainage:

- A valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin.
- Evaporation basins are an acceptable interim disposal method for agricultural subsurface drainage and may be an acceptable permanent disposal method in the absence of a valley drain provided that water quality is protected and potential impacts to wildlife are adequately mitigated. For existing basins requiring substantial physical improvements and other mitigations, some of which are dependent upon empirically derived techniques, operators shall implement mitigations as early as feasible.

- Persons proposing new evaporation basins and expansion of evaporation basins shall submit technical reports that assure compliance with, or support exemption from, Title 23, California Code of Regulations, Section 2510, et seq., and that discuss alternatives to the basins and assess potential impacts of and identify appropriate mitigations for the proposed basins.

- Agricultural drainage may be discharged to surface waters provided it does not exceed 1,000 μmhos/cm EC; 175 mg/l chloride, nor 1 mg/l boron. Other requirements also apply.

LOWER KINGS RIVER

The Lower Kings River from Peoples Weir to Stinson Weir on the North Fork and Empire Weir #2 on the South Fork is a Water Quality Limited Segment (see discussion regarding water quality limited segments later in this chapter) because of high salinity. Studies indicate that the source of the salinity is either surface or subsurface agricultural drainage. Levels of boron, molybdenum, sulfates, and chlorides in the Lower Kings River are high enough to impact agricultural uses and aquatic resources. Additional information is necessary to further characterize discharges to this section of the Kings River. A monitoring program is described in Chapter VI. In the meantime, drainage should be reduced by the use of at least the following management practices:

- Maximize distribution uniformity of irrigation systems.
- Minimize or eliminate pre-irrigation.
- Control the amount of water applied to each crop so it does not exceed the evapotranspiration needs of the crop and a reasonable leaching factor.
- Minimize seepage losses from ditches and canals to the extent feasible by lining them or replacing them with pipe.
During periods of extreme dry conditions when dilution flows in the River are very low, farmers in the area should temporarily remove poorly drained land from production.

AGRICULTURAL CHEMICALS

Pesticides and nutrients in agricultural drainage have found their way to ground waters in many areas of the basin. Nitrate and pesticide levels exceeding the State drinking water standards occur in some ground waters in the basin, and have caused closure of domestic supply wells in several locations. One of the biggest problems facing municipal water providers is the presence of the chemical dibromochloropropane (DBCP) in their wells. The fumigant was widely used in the 1960’s to control nematodes in vineyards and can now be found in wells down gradient of the use areas. Providers sued the manufacturers to recover damages and, as of 1995, most providers within the Valley have settled. State and local agencies are searching for methods to mitigate this problem.

The Department of Pesticide Regulation investigates reported cases of pesticide residues in ground water. Where contamination is confirmed to be through legal use of a pesticide, the Department designates a pest management zone after holding a public hearing. Use of the pesticide of concern is modified within the management zone created for it. Responsibility for water quality, however, remains with the State and Regional Water Boards. There is a Memorandum of Understanding between the State Water Board and the Department of Pesticide Regulation describing the role of each agency with regard to pesticide regulation.

Agricultural chemical applicators have been a source of pollution from spills, and improper containment and disposal of water used to clean equipment or work areas. The application facilities fall under Regional Water Board regulatory programs. When appropriate management practices are implemented, waste discharge requirements may be waived (see Appendices 27 and 28, which are incorporated by reference into this plan). Regional Water Board staff also inspect high risk sites to evaluate compliance. Enforcement strategies are implemented as warranted.

Confined Animal Activities

The Tulare Lake Basin is a fast-growing animal and milk production area. With urban pressures increasing in other parts of the State, dairymen and poultry operators are moving into the Basin. In 1994, Tulare County had the largest number of cows in the United States. Tulare County was also the top milk producing county in the United States.

Where not controlled, surface runoff from such operations can impair both surface and ground water beneficial uses. Uncontrolled runoff can also cause nuisance conditions. Disposal of washwater and manure must occur in a manner that protects both surface and ground waters.

Animal wastes may produce significant bacteria, organic, nitrate, and TDS contamination. The greatest potential for water quality problems has historically stemmed from the overloading of the facilities’ waste containment and treatment ponds during the rainy season and inappropriate application of waste water and manure. Overloading sometimes results in discharge of manure waste to canals and drainageways. Most animal confinement facilities have some crop land available for wastewater and spreading manure; the lands assimilative capacity will depend upon area, crop, crop yield, soil, and season of the year. When land and capacity is exceeded, the excessive salts and nutrients are leached to the underlying ground water. Where land is not available, agreements between the operator and other landowners can increase area available for disposal.

Title 23, California Code of Regulations, Section 2510-2601 (Chapter 15) contains minimum standards to protect both surface and ground waters from discharges of animal waste at confined animal facilities.

In addition to the standards in Chapter 15, the following is required:

- Lands that receive dry manure shall be managed to minimize erosion and runoff, and applied manure shall be incorporated into surface soils soon after manure application.
- Animal confinement areas, manure storage areas, lagoons, disposal fields, and crop lands that receive manure shall not create a nuisance.
- Salt in animal rations should be limited to the amount required to maintain animal health and optimum production.
- Animal confinement facilities, including retention ponds, shall be protected from overflow from stream channels during 20-year peak stream flows for facilities that existed as of 25 July 1975 and protected from 100-year peak stream flows for facilities constructed after 25 July 1975. Facilities
constructed after 8 December 1984 must comply with the specifications in Chapter 15.

- Facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm. Facilities with operation capacities equal to or greater than the capacities described in 40 CFR 412 (Feedlots Point Source Category) must obtain a National Pollutant Discharge Elimination System (NPDES) permit prior to discharge for events greater than a 25 year, 24 hour storm. (See “Storm Water” section for additional information regarding stormwater regulation.)

- New manure retention ponds shall be sited, designed, constructed, and operated to ensure that the invert of the pond will be at least 5 feet above the highest anticipated elevation of underlying ground water.

Waste discharge requirements for the land application of wastewater may be conditionally waived for animal confinement facilities that can demonstrate compliance with the above. This waiver does not waive responsibility of the facility owner or operator to apply for and comply with a storm water permit. Facilities for which waste discharge requirements are waived shall provide an annual report to the Regional Water Board describing land and waste management practices for the past year. The annual report should summarize the following:

1. Inventory of total head of milking cows, dry cows, heifers, calves, and comparable number of animal units at the dairy during the year.

2. Crops and acreage used for wastewater disposal (irrigation application).

3. Estimates of the quantity of dry manure (tons) spread on site and exported off site, including the location of the fields where the manure is applied, and the names of buyers, and/or locations of application (disposal) areas, if applicable.

Unconfined Animals

Grazing animals can contribute bacteria and pathogens to surface waters, just as wildlife do. The greatest potential problem, though, is erosion resulting from overgrazing. Grazing impacts are generally considered nonpoint source pollution. Due to the diffuse nature of this type of pollution, the State Water Board’s Nonpoint Source Management Plan recommends that land use entities in an affected area develop a coordinated resource management plan with Regional Water Board assistance. Good grazing management will prevent pollution and impairment of water quality.

Overdraft

The elimination of overdraw is an important step in managing the rate of salinity increase in the ground water. Continued overdraw will deplete good quality water supplies and introduce salts from poorer quality aquifers.

Continued overdraw has other effects, such as increased costs to overlying landowners from greater pumping lifts, depletion of local ground water, and possible deep subsidence in certain soils with permanent loss of ground water storage capacity.

Various measures can reduce overdraw. Measures include improving efficiency of water use by domestic, industrial, and agricultural users; expanded ground water recharge; watershed management; and development of new sources of supply. The solution to the overdraw problem requires a combination of management programs.

The Regional Water Board goal is to alleviate overdraw and the water quality problems associated with overdraw, and extend the beneficial uses of the ground water resource for the longest period economically feasible. Water used to recharge ground water and imported water supplies must be of the highest quality possible. Banking of water in the ground is encouraged. Construction of storage facilities to store surplus wet-weather basin outflows is also recommended where such facilities do not adversely impact other waters of the state.

Salinity

Degradation of ground water in the Tulare Lake Basin by salts is unavoidable without a plan for removing salts from the Basin. A valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin. The drain would carry wastewater generated by municipal, industrial, and agricultural activities, high in salt and unfit for reuse. The only other solution is to manage the rate of degradation by minimizing the salt loads to the ground water body.

Some of the salt load to the ground water resource is primarily the result of natural processes within the
Basin. This includes salt loads leached from the soils by precipitation, valley floor runoff, and native surface waters.

Salts that are not indigenous to the Basin water resources result from man's activity. Salts come from imported water, soil leached by irrigation, animal wastes, fertilizers and other soil amendments, municipal use, industrial wastewaters, and oil field wastewaters. These salt sources, all contributors to salinity increases, should be managed to the extent practicable to reduce the rate of ground water degradation.

The Regional Water Board supports construction of a valleywide drain to remove salt-laden wastewater from the Basin under the following conditions:

- All toxicants would be reduced to a level which would not harm beneficial uses of receiving water.
- The discharge would be governed by specific discharge and receiving water limits in an NPDES permit.
- Long-term continuous biological monitoring would be required.

The Regional Water Board also encourages proactive management of waste streams to control and manage salts that remain in the Basin. Application or disposal of consolidated treated effluents should be to the west, toward the drainage trough of the valley. If feasible, salts in waste streams should be processed for reuse to reduce the need to import salt. Salt import should be reduced by assuring that imported water is of the highest quality possible. Water conveyance systems used to import water into the Basin should not be used to transport inferior quality water.

Silviculture

Forest management activities, principally timber harvesting and application of herbicides, have the potential to impact beneficial uses.

Timber harvest activities occur annually on tens of thousands of acres of private and federal land in the Basin and they may affect water quality throughout the area being harvested. Logging debris may be deposited in streams. Landslides and other mass soil movements can also occur as a result of timber operations. The amount of sediment washed from a logged area is directly proportional to the density of roads and skid trails in the area. Thus, the area used for roads, skid trails, and landings should be minimized.

Proper drainage should be provided. Crossings of streams and other natural channels must be kept to a minimum. Activities (particularly, use of mechanical equipment) in wet meadow areas should be minimized. Disturbed areas should be reseeded or should receive erosion control treatment. The U.S. Forest Service and the California Department of Forestry and Fire Protection designates zones in each harvest area where the activities are closely controlled to protect the quality of water in streams and lakes. These water protection zones reflect the degree of erosion hazard in the tributary areas and apply in all areas where man's activities threaten to degrade the quality of waters in the streams.

Herbicides are sometimes used in silviculture to reduce commercial timber competition from weeds, grasses, and other plants, or to prepare a site for planting of commercial species by eliminating existing vegetation. Problems associated with use of herbicides in forests in the Tulare Lake Basin are not well documented, although there is concern that there may be transport from target sites to streams by wind and water runoff. The U.S. Forest Service and the California Department of Forestry and Fire Protection should keep records of all pesticides, herbicides, or fertilizers used for forest and range management, for insect and disease control, or for fire control, stating the time, place, reason for use, and amounts used. To the extent feasible, such materials shall be precluded from entering streams.

The State and Regional Water Boards entered into agreements with both the U.S. Forest Service and the California Department of Forestry and Fire Protection. These agreements require these agencies to control nonpoint source discharges by implementing control actions certified by the State Water Board as best management practices. The Regional Water Board enforces compliance with best management practices and may impose control actions above and beyond what is specified in the agreements, such as adoption of waste discharge requirements, if the practices are not applied correctly or do not adequately protect water quality.

Mineral Exploration and Extraction

Drainage and runoff from mines and various operations associated with mining can result in serious impacts to ground and surface water beneficial uses, if not properly managed. Efforts to control drainage have gradually expanded over the years. A staff assessment of mine water quality problems, done in 1979, identified an approach to the problems (see
Attractive, convenient, and adequate toilet facilities, fish cleaning sinks, and disposal containers should be provided to prevent disposal in or near surface waters. Measures should be implemented to reduce lake bank erosion, such as reducing boat speeds near banks. Programs and procedures, developed from studies where necessary, must be adopted for processing and disposal of solid wastes and vault toilet pumpings from recreational areas. Educational programs on proper handling and disposal of wastes must be made available to classes and groups who would apply the techniques.

Well Standards

Improper well construction, maintenance, abandonment, or destruction can lead to contamination of ground water. California Water Code, Section 13801, requires all counties to adopt water well standards in accordance with Department of Water Resources Bulletin No. 74-81: “Water Well Standards: State of California,” and Bulletin No. 74-90: “California Well Standards.” Counties in the Tulare Lake Basin have established well standards equal to or more stringent than those in the bulletin.

Controlled Burning

Controlled burning is a method to regulate growth of some chaparral species and encourage the growth of preferable trees and grasses. Controlled burning helps prevent wildfire and uncontrolled burns. Burning changes the character of eroded matter from organic to mineral and may increase the contribution of material to streams. Burned areas, whether from controlled or uncontrolled burns, should be managed to minimize erosion of materials into streams.

Municipal and Domestic Wastewater

Increasing population and a higher standard of living require continuing expansion of wastewater treatment facilities. Advances in technology, normal equipment deterioration, and higher performance expectations require continuing replacement of these facilities. Expansion and replacement of municipal wastewater treatment facilities are integral components of the wastewater management program. Wastewater facilities should be evaluated periodically to determine if they adequately meet long-term needs, i.e., 20 years in the future. Financial programs must include a capital replacement fund to provide for these future needs. New land developments should include collection and treatment facilities as part of the initial plans.

The Regional Water Board regulates all municipal wastewater discharges to protect the quality and beneficial uses of ground water and surface water resources, to maximize reclamation and reuse, and to eliminate waste associated health hazards.

Municipal and industrial point source discharges to surface waters are generally controlled through National Pollutant Discharge Elimination System (NPDES) permits. Although the NPDES program is established by the federal Clean Water Act, the permits are prepared and enforced by the regional water boards through program delegation to California and implementing authority in the California Water Code.

The Regional Water Board will issue NPDES permits and waste discharge requirements for municipal wastewater discharges to protect water quality. Dischargers will be required to reclaim and reuse wastewater whenever reclaimation is feasible.

To prevent nuisance, dischargers are required to manage vegetation on their respective facilities. However, birds may utilize this same vegetation during nesting season, creating a potential conflict between the Health and Water Codes and the Fish and Game Code. In accordance with a Memorandum of Understanding between the Department of Fish and Game and Mosquito Abatement Districts in the Tulare Lake Basin (copy is Appendix 25), vegetation management operations should be conducted so that weed removal operations are not necessary when nesting takes place, which is between April 1 and June 30.

Individual Waste Systems

Control of individual waste treatment and disposal systems can best be accomplished by local county environmental health departments if these departments are strictly enforcing an ordinance that is designed to provide complete protection to ground and surface waters as well as public health. The Regional Water Board's policies and guidelines for waste disposal from land developments is in Appendix 32, which is included by reference into this plan.

The Regional Water Board will consider adoption of a ban on new septic tank systems and elimination of existing systems in areas where the systems contaminate underlying ground water or where a substantial percentage of existing systems fail annually. In making this determination, the Regional Water Board must consider the factors listed in Section 13281 of the
comply with Section 301 of the Clean Water Act. Point source discharges to land must comply with waste discharge requirements developed according to California Water Code Section 13577 and Section 13263, respectively. NPDES permits must be renewed every 5 years. Other waste discharge requirements must be reviewed every 5, 10, or 15 years depending upon the threat to water quality of the discharge.

The effluent limits presented in the following sections of this chapter are the minimum treatment level which must be provided.

**Discharges to Navigable Waters**

40 CFR 125 requires publicly owned treatment works to provide secondary treatment and best practicable waste treatment technology, or provide adequate treatment to meet the water quality standards, whichever is more stringent. (40 CFR 133 defines secondary treatment as removal of 85 percent or reduction to 30 mg/l, whichever is more stringent, of both 5-day BOD and suspended solids.) Effluent limitations for other point sources are also described in 40 CFR 125. Special limitations for certain types of industrial discharges are defined in the 40 CFR 400 series. These sources must provide best practicable control technology currently available.

The following policy shall govern waste discharges to navigable waters in the Tulare Lake Basin:

- Discharges to surface waters will not be considered a permanent solution when the potential exists for wastewater reclamation.
- Discharge to ephemeral streams or to streams that have limited dilution capacity will not be considered a permanent solution unless it is accomplished in such a manner as to safeguard the public health and prevent nuisances, and the wastewater is of such a quality that it benefits streamflow augmentation.
- Dischargers in mountain areas must evaluate land disposal as an alternative. Where studies show that year-round land disposal is not practicable, dischargers must evaluate dry season land disposal as an alternative.

As a minimum, dischargers to surface waters, including stream channels, shall comply with the following effluent limits:
All domestic discharges shall be adequately treated and disinfected to reliably meet wastewater reclamation criteria (Title 22, California Code of Regulations, Division 4, Section 60301, et seq.).

The maximum electrical conductivity (EC) of a discharge shall not exceed the quality of the source water plus 500 micromhos per centimeter or 1,000 micromhos per centimeter, whichever is more stringent. When the water is from more than one source, the EC shall be a weighted average of all sources.

Discharges shall not exceed an EC of 1,000 micromhos per centimeter, a chloride content of 175 mg/l, or a boron content of 1.0 mg/l.

In addition to the above, discharges to waters having an EC or water quality objective of less than 150 micromhos shall comply with the following:

- Complete removal of settleable and floatable solids
- Nutrient removal as necessary to control biostimulation
- Removal of dissolved solids to levels consistent with those of the receiving waters
- Ammonia removed as necessary to protect aquatic life.
- Substantially complete removal of any substance known to be toxic to plant and/or animal life.

Discharges to Land

Wastewater treatment facilities that discharge to land in a manner that waste may infiltrate below the ground surface and degrade ground water must also comply with effluent limits. The excellent quality of ground waters along the easterly edge of the Basin should be protected by encouraging the application or disposal of consolidated treated effluents to the west, toward the drainage trough of the valley.

The levels of treatment required of all domestic wastewater facilities with land disposal are as follows:

1. Primary: Primary treatment is acceptable only under exceptional circumstances, typically a relatively minor discharge in an isolated location where there is little risk of nuisance or water quality degradation. Treatment and disposal in some instances could be provided by septic tanks and a leach field. Increased amounts of wastewater or nuisance conditions would require an upgrade in level of treatment.

2. Advanced Primary: This treatment may be satisfactory for smaller facilities in outlying or remote areas where the potential for odors and other nuisances is low. Advanced primary shall provide removal of 60 to 70 percent or reduction to 70 mg/l, whichever is more restrictive, of both 5-day BOD and suspended solids.

3. Secondary Treatment: Secondary treatment should remove 85 percent or reduce to 30 mg/l, whichever is more restrictive, of both 5-day BOD and suspended solids. Secondary treatment may be required where public access to wastewater is not precluded.

Most wastewater discharges will be adequately precluded from public access and secondary treatment will not be necessary. Facilities which discharge or are designed to discharge in excess of 1 million gallons per day must provide removal of 80 percent or reduction to 40 mg/l, whichever is more restrictive, of both 5-day BOD and suspended solids. Smaller facilities (less than 1 million gallons per day) in close proximity to an urbanized area or using particular methods of effluent disposal (e.g., irrigation of certain types of crops) will also be required to provide 80 percent removal or reduction to 40 mg/l, whichever is more restrictive, of both 5-day BOD and suspended solids.

4. Advanced Wastewater Treatment: Reclaimed water used for the spray irrigation of food crops must also be coagulated and filtered. Coagulated wastewater means oxidized wastewater in which colloidal and finely divided suspended matter have been destabilized and agglomerated by the addition of suitable flocculating chemicals or by an equally effective method. Filtered wastewater means an oxidized, coagulated, clarified wastewater which has been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth, so that the turbidity does not exceed an average operating turbidity of 2 NTUs and does not exceed 5 NTUs more than 5 percent of the time during any 24-hour period [Title 22, California Code of Regulations, Section 60301, et seq.].
Additional effluent limits follow:

- The incremental increase in salts from use and treatment must be controlled to the extent possible. The maximum EC shall not exceed the EC of the source water plus 500 micromhos/cm. When the source water is from more than one source, the EC shall be a weighted average of all sources.

- Concentration of total coliform organisms in reclaimed wastewater must be in accordance with limits established in the following provisions of Title 22, California Code of Regulations: Sections 60303 (Spray Irrigation of Food Crops), 60305 (Surface Irrigation of Food Crops), 60311 (Pasture for Milking Animals), 60315 (Landscape Irrigation), 60316 (Nonrestricted Recreational Impoundment), 60317 (Restricted Recreational Impoundment), and 60319 (Landscape Impoundment).

- In the Pogo Creek Subarea, discharges shall not exceed 1,000 micromhos/cm EC, 200 mg/l chlorides, and 1.0 mg/l boron. The Pogo Creek subarea consists of about 35,000 acres of land between State Highways 99 and 65 about six miles north of Bakersfield, and is defined more specifically in Regional Water Board Resolution No. 71-22, which is incorporated by reference into this plan.

- In the White Wolf Subarea, for areas overlying Class I irrigation water, discharges shall not exceed 1,000 micromhos/cm EC, 175 mg/l chlorides, 60 percent sodium, and 1.0 mg/l boron. For areas overlying Class II or poorer irrigation water, discharges shall not exceed 2,000 micromhos/cm EC, 350 mg/l chlorides, 75 percent sodium, and 2 mg/l boron. In areas where ground water would be Class I except for the concentration of a specific constituent, only that constituent will be allowed to exceed the specified limits for Class I water. In no case shall any constituent be greater than those limits specified for areas overlying Class II irrigation water. The White Wolf subarea consists of 64,000 acres within the valley floor, at the southern tip of the Tulare Lake Basin, about 20 miles south of Bakersfield. The subarea is bounded on the west by the San Emidgio Mountains, on the south and east by the Tehachapi Mountains, and on the north by the White Wolf Fault.

Criteria for mineral quality of irrigation water is described below:

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</table>

- Discharges to areas that may recharge to good quality ground waters shall not exceed an EC of 1,000 micromhos per centimeter, a chloride content of 175 mg/l, or a boron content of 1.0 mg/l.

Wastewater Reclamation

Reclaimed water provides a substitute source of water and provides nutrients that nourish crops. When properly managed, reclamation consumes nitrites and effluent that would normally percolate to local ground waters underlying a community and can free up potable water for growth or other uses. Extensive reclamation is a practical necessity simply to maintain present levels of development and activity in the Basin.

Wastewater reclamation shall be maximized by controlling or limiting salt pickup and evaporation during use, treatment, or disposal. Integration of final disposal into existing surface distribution systems appears to be advantageous. Wherever feasible, eventual wastewater reclamation will be requested.

Title 22, California Code of Regulations, establishes reclamation criteria for direct use of reclaimed water but has no criteria for wastewater distributed with irrigation supplies. Therefore, municipal treatment facilities producing effluent for introduction to irrigation canals for unrestricted irrigation will be required, as a minimum, to disinfect to 23 MPN coliform per 100 ml. The Department of Health Services will be consulted for all cases.

To facilitate the use of treated wastewater with short notice, wastewater reclamation requirements may be waived for up to one year provided that the following conditions are met:

1. The reclaimed water will comply with any applicable criteria provided by Title 22, Division 4, California Code of Regulations;

2. The proposed uses receive prior approval from the state and local health departments and the Executive Officer; and
3. The reclamation project is consistent with the "Guidelines for Use of Reclaimed Water" developed by the Department of Health Services. The "Guidelines for Use of Reclaimed Water" is incorporated by reference into this plan. (See Appendix 34.)

Reclamation projects more than one year in duration may be allowed to proceed prior to final approval of reclamation requirements provided that the use complies with reclamation criteria.

Waste discharge requirements will be revised and wastewater reclamation requirements adopted as soon as possible to allow reuse. No enforcement actions will be taken against a community allowing wastewater reuse prior to revision of waste discharge requirements provided that the use complies with reclamation criteria.

Reclamation policies are as follows:

- Discharges to surface water and evaporation of reclaimable wastewater will not be acceptable permanent disposal methods where opportunity exists to replace an existing use or proposed use of fresh water with reclaimed water; a timetable for reclamation or reuse may be set by the Regional Water Board.

- The quality of waste discharges shall be regulated to promote reclamation and reuse wherever feasible.

- Rates of wastewater application that exceed reasonable agronomic rates will not be considered as reclamation or reuse.

- Project reports for new or expanded wastewater facilities shall include plans for wastewater reclamation or the reasons why this is not possible.

- Where studies show that year-round or continuous reuse of all of the wastewater is not practicable, consideration shall be given to partial reuse of the flow and seasonal reuse.

The irrigation season in the Tulare Lake Basin area typically extends 9 to 10 months, but monthly water usage varies widely. To maximize reuse, users should provide water storage and regulating reservoirs, or percolation ponds that could be used for ground water recharge of surplus waters when there is no irrigation demand.

State Water Board policy, described in Resolution No. 77-1, Appendix 4, encourages and provides funds for reclamation projects that protect beneficial uses of existing water supplies, encourage water conservation, and encourage other agencies to assist in implementation.

Consolidations

Proliferation of small treatment plants in developed areas is undesirable. Most small communities do not have adequate resources to properly manage, treat and dispose of wastewater in an urban environment. Typical problems involve nuisance and ground water pollution. Small communities and development close to other small communities may be able to construct and operate a joint wastewater treatment facility with greater treatment ability, opportunity for reclamation, and for lower cost. Policies on consolidation are as follows:

- Adjoining small communities should combine resources to construct and operate a joint or regional wastewater treatment plant.

- Consolidation, whether one or more regional facilities operated by a single sewer authority, should be cost-effective, and consider benefits to the ecology, treatment efficiencies, and effective reuse of the waters.

- Unsewered areas and new developments adjacent to or within existing wastewater collection system service areas should be connected to the system. Developments not within a service area but within the projected sphere of influence of a regional system should be developed in a manner that provides for future connection to the system when the regional sewer system becomes available. One condition of approval of individual sewage disposal systems in certain areas and of certain densities may be that developments be dry sewered in a manner that provides cost-effective sewerage infrastructure to be placed during initial construction.

- Each municipal facility should act as a regional facility and provide sewerage services within its sphere of influence. The municipality must be equitably compensated for these services.

- Areas recommended for consolidation of wastewater systems are the Parlier area, the Bakersfield area, and the City of Delano. The Selma-Kingsburg-Fowler (Tri-Cities) and Fresno-Clovis regions have been consolidated. Consolidations of other wastewater treatment plants may be justified at some future time.

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The intent of this policy is to make consolidation the rule rather than the exception. Consolidation should be compared to other approaches. If such a comparison yields clear technical, environmental, or economic advantages for consolidating, then consolidation should be implemented.

Pretreatment

Many municipal facilities in the Basin treat significant volumes of industrial wastewater. Most of this wastewater is from agriculture-related industries that fluctuate seasonally. Requirements for industrial users that discharge directly to surface water or to land are in the "Industrial Wastewater" Section of this chapter. Indirect industrial users discharge to a municipal wastewater treatment system and are regulated by the municipal discharger. Policies on pretreatment are as follows:

- All publicly owned treatment works (POTWs) with a design flow greater than 5.0 million gallons per day must comply with 40 CFR 403, the federal pretreatment program requirements.

- Smaller POTWs with industrial flows which may cause pass-through or interference may also be required to develop pretreatment programs.

- All industrial users that discharge to POTWs must comply with the National Pretreatment Standards regardless of whether the POTW has an approved pretreatment program.

Industrial Wastewater

The number of known cases of ground water pollution or public nuisance attributable to industrial sources has increased steadily over the last decade. Much of the increase is due to sources such as underground tanks that were never intended to discharge but which leaked undetected for years. The Region's inventory of underground storage tanks indicates a high number of leaking tanks. Ground water contamination from other industrial sources generally occurs from the illegal discharge of fluids or other materials used in production processes. Waste compounds have been discharged directly to unlined sumps, pits, or depressions and spread on soils. In some cases, these disposal practices went on for many years before they were discovered or discontinued.

There are two types of industrial dischargers: direct and indirect. Indirect dischargers are those who discharge into community wastewater systems. The federal regulations require that all indirect users abide by general National Pretreatment Standards and that certain categories of indirect users comply with specific discharge standards. (See Pretreatment Section, above.)

Direct dischargers discharge to either surface water or land. Surface water dischargers are subject to federal and state regulations. Federal regulations require dischargers to comply with best conventional pollutant control technology (BCT), best practicable control technology currently available (BPT), or best available technology economically achievable (BAT). Effluent limitations for specific industrial waste discharges to surface waters, together with standards of performance and pretreatment standards for new sources, are found in 40 CFR 400. Waste source categories of particular interest in the Tulare Lake Basin include dairy product processing, meat product and rendering processing, canned and preserved fruit and vegetable processing, beet sugar processing, and petroleum production and refining. When treatment technology is not defined, regulations specify use of best practicable judgment (BPT).

Generally, the effluent limits established for municipal waste discharges will apply to industrial wastes. Industrial dischargers shall be required to:

1. Comply with water quality objectives established in Chapter III.

2. Comply with Chapter 15 for discharges of designated or hazardous waste unless the discharger demonstrates that site conditions and/or treatment and disposal methods enable the discharge to comply with this Basin Plan and otherwise qualify for exemption from Chapter 15.

3. Comply with effluent limitations set forth in 40 CFR 400 when discharge is to surface water.

4. Comply with, or justify a departure from, effluent limitations set forth in 40 CFR 400 if discharge is to land.

5. Limit the increase in EC of a point source discharge to surface water or land to a maximum of 500 µmhos/cm. A lower limit may be required to assure compliance with water quality objectives.

An exception to this EC limit may be permitted for industrial sources when the discharger technically demonstrates that allowing a greater net incre-
mental increase in EC will result in lower mass emissions of salt and in conservation of water, provided that beneficial uses are protected.

An exception may also be permitted for food processing industries that discharge to land and exhibit a disproportionate increase in EC of the discharge over the EC of the source water due to unavoidable concentrations of organic dissolved solids from the raw food product, provided that beneficial uses are protected. Exceptions shall be based on demonstration of best available technology and best management practices that control inorganic dissolved solids to the maximum extent feasible.

Cull fruits and wastes from food processing generally are voluminous and may have a high water content like winery wastes. Provision should be made for thin spreading of such materials on the fields, followed promptly by disking into the soil.

6. The Regional Water Board encourages the reclamation and reuse of wastewater, including treated ground water resulting from a cleanup action, where practicable and requires as part of a Report of Waste Discharge an evaluation of reuse and land disposal options as alternative disposal methods. Reuse options should include consideration of the following, where appropriate, based on the quality of the wastewater and the required quality for the specific reuses: industrial and municipal supply, crop irrigation, landscape irrigation, ground water recharge, and wetland restoration. Where studies show that year-round or continuous reuse or land disposal of all the wastewater is not practicable, the Regional Water Board will require dischargers to evaluate how reuse or land disposal can be optimized, such as consideration of reuse/disposal for part of the flow and seasonal reuse/disposal options (e.g., dry season land disposal).

7. Unless an exception is technically justified, segregate domestic waste from industrial waste, and treat and dispose of domestic waste according to the policy for municipal and domestic wastewater.

Additional specific requirements have been adopted for wastewater from oil fields and wineries.

Oil Field Wastewater

Hydrocarbon production in the San Joaquin Valley’s 74 oil fields generates significant volumes of wastewater. Oil field producers continue to use hundreds of sumps as oil/wastewater separators and as wastewater disposal sumps. Some oil field wastewaters contain salts, oil and grease, metals, and organics which can present a threat to the beneficial uses of underlying good quality ground water. However, in some areas, wastewater may be of a quality which allows its reuse for reclamation or discharge to surface waters. In these instances, waste discharge requirements or NPDES permits, as appropriate, are issued. In addition, some ground water in the Basin is naturally of such poor quality that oil field wastewater will not impact its beneficial uses. Due to historical practices, degradation of ground water from oil field wastewater disposal occurred in some areas. The petroleum industry has been eliminating oilfield wastewater disposal sumps.

With the gradual elimination of the use of sumps for disposal, increased amounts of produced wastewater are being discharged to Class II injection wells. Title 14, California Code of Regulations, Section 1724.6, et seq., defines environmental protection regulations relating to oil and gas operations administered by the California Department of Conservation, Division of Oil, Gas & Geothermal Resources in cooperation with other state regulatory agencies. The Department of Conservation administers the federal underground well injection program for Class II injection wells within the state. The Regional Water Board reviews and may comment on the permit application regarding water quality concerns. The review process is in accordance with a Memorandum of Agreement between the State Water Board and the Department of Conservation. The purpose of the agreement is to ensure that the construction or operation of Class II injection disposal wells and the land disposal of wastewaters from oil, gas, and geothermal production facilities does not cause degradation of waters of the state. The Memorandum of Agreement provides a coordinated approach that results in a single permit satisfying the statutory obligations of both agencies.

The Memorandum of Agreement also requires the Department of Conservation to notify the Board of all pollution problems, including spills associated with operators and/or new proposed oil field discharges. The agencies must work together, within certain timelines, to review and prepare permits and coordinate enforcement actions.

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Policies regarding the disposal of oil field wastewater are:

- Maximum salinity limits for wastewaters in unlined sumps overlying ground water with existing and future probable beneficial uses are 1,000 μmhos/cm EC, 200 mg/l chlorides, and 1 mg/l boron, except in the White Wolf subarea where more or less restrictive limits apply. The limits for the White Wolf subarea are discussed in the "Discharges to Land" subsection of the "Municipal and Domestic Wastewater" section.

- Discharges of oil field wastewater that exceed the above maximum salinity limits may be permitted to unlined sumps, stream channels, or surface waters if the discharger successfully demonstrates to the Regional Water Board in a public hearing that the proposed discharge will not substantially affect water quality nor cause a violation of water quality objectives.

- Disposal sumps shall either be free of oil or effectiveness covered or screened to preclude entry of birds or animals. Compliance monitoring for wildlife problems shall continue to be deferred to the Department of Conservation and the Department of Fish and Game. The Regional Water Board will respond to complaints, spot check for compliance, and enforce conditions as necessary.

- Sumps adjacent to natural drainage courses shall be protected from inundation or washout, or properly closed.

- Regulation of oil field dischargers shall be coordinated with all other state and federal agencies having jurisdiction and interest in the oil field.

- The discharge of produced wastewater to land, where the concentration of constituents may cause ground water to exceed water quality objectives, shall be subject to the requirements contained in the California Code of Regulations, Title 23, Section 2510, et seq. (Chapter 15).

Wineries

A substantial number of wineries operate throughout the Central Valley. Many of these wineries produce substantial quantities of stillage waste which is high in concentrations of BOD, EC, TDS, and nitrogen. As stillage is normally discharged directly to land without any prior treatment, there is significant potential for the waste to affect water quality and to create nuisance conditions if not managed properly.

A study conducted in 1980 developed recommendations for minimizing water quality effects and nuisance conditions resulting from land application of stillage waste (Metcalfe and Eddy, "Land Application of Stillage Waste: Odor Control and Environmental Effects"). Based on the study, the Regional Water Board adopted guidelines for the land disposal of stillage waste from wineries. These guidelines may not be sufficient where local soil, ground water, weather, or other conditions are not compatible with the stillage to be disposed. These guidelines prescribe the minimum requirements for disposal of stillage waste from wineries and do not preclude the establishment of more stringent requirements as necessary to comply with water quality objectives. The policy for land disposal of stillage waste is presented below.

Storm Water

Runoff from residential and industrial areas can contribute to water quality degradation. Urban storm water runoff contains organics, pesticides, oil, grease, and heavy metals. Because these pollutants accumulate during the dry summer months, the first major storm after summer can flush a highly concentrated load to receiving waters and catch basins. Combined storm and sanitary systems may result in some runoff to wastewater treatment plants. In other cases, storm water collection wells can produce direct discharges to ground water. Impacts of storm water contaminants on surface and ground waters are an important concern.

EPA has promulgated regulations for municipal and industrial stormwater permits in 40 CFR 122. The State Water Board implemented these regulations by adopting a General Industrial Activities Storm Water Permit (excluding construction activity) and a General Construction Activity Storm Water Permit. Storm water dischargers indicate intention to follow the specifications in the appropriate permit by filing a Notice of Intent with the State Water Board.

The Regional Water Board will take all measures necessary to protect the quality of surface and ground waters from treatment or disposal of urban runoff.

- The Regional Water Board will issue waste discharge requirements on the discharge of urban runoff when a threat to water quality exists.

- The Regional Water Board will regulate large and medium municipal stormwater dischargers and, at its discretion, specific industrial dischargers through the issuance of individual NPDES permits. Industrial dischargers may also be

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Land Disposal of Stillage Waste from Wineries

Rapid Infiltration Method for Disposal of Stillage:

A. Disposal Site Requirements

1. Land for disposal should be as remote from habitation as possible.
2. Soils should be capable of infiltrating 3 to 4 inches of stillage in 24 hours or less.
3. Soil permeability should be greater than 2 inches per hour for the entire profile.
4. There should be no unripped hardpan within the top 10 feet of the soil profile.
5. Soil depth should be 10 feet or greater.
6. Depth to ground water should be 10 feet or greater.

B. Operational Procedures

1. Cooling water and any other wastewaters with low COD concentrations should be separated from the stillage before land application.
2. Stillage waste should be spread on land between long, narrow, level checks. The surface should be leveled uniformly within 0.1 foot per 100 feet, without potholes.
3. At the inlet of the checks, the flow should be distributed using splash plates or other devices to prevent deep holes from forming.
4. The depth of each stillage application should not exceed the following:

<table>
<thead>
<tr>
<th>Period of Year</th>
<th>Depth of Stillage Application (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 1 to Oct 1</td>
<td>3.7</td>
</tr>
<tr>
<td>Oct 1 to Dec 1</td>
<td>3</td>
</tr>
<tr>
<td>Dec 1 to May 1</td>
<td>2.5</td>
</tr>
</tbody>
</table>

5. Standing stillage should not be present 24 hours after application has ceased.

6. After stillage waste has been applied to an area, the area should be allowed to dry for at least the following period before re-application of waste:

<table>
<thead>
<tr>
<th>Period of Year</th>
<th>Drying Time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 1 to Oct 1</td>
<td>6</td>
</tr>
<tr>
<td>Oct 1 to Dec 1</td>
<td>9</td>
</tr>
<tr>
<td>Dec 1 to May 1</td>
<td>13</td>
</tr>
</tbody>
</table>

7. After stillage has been applied to an area, if leathers have not been removed, the area should be raked, rototilled, or an equivalent method should be used before re-application of stillage.

8. Loading rates and drying times for stillage waste from raisins or pomace should follow the criteria for December 1 to May 1 operations.

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9. Land area used for disposal should equal or exceed the following:

<table>
<thead>
<tr>
<th>Period of Year</th>
<th>Land Area † (acres per 100,000 gpd of stillage waste)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 1 to Oct 1</td>
<td>7</td>
</tr>
<tr>
<td>Oct 1 to Dec 1</td>
<td>12.3</td>
</tr>
<tr>
<td>Dec 1 to May 1</td>
<td>20.6</td>
</tr>
</tbody>
</table>

† These land areas are directly related to the drying time stated in No. 6 above. Complete infiltration recovery to the original values may not be obtained by these relatively short resting cycles. At some application sites, the infiltration rate constantly decreases as the application season progresses. A decrease in infiltration of about 75% can be expected with only three applications. Therefore, the number of stillage applications at a specific site should be kept to a minimum. Repeated applications of stillage allowing only minimum drying times may require larger land areas.

10. During periods when it is not used for stillage disposal, the disposal area should be planted with crops to assist in the removal of residual nitrogen concentrations from the soil if necessary.

Slow Rate Irrigation Method:

Most existing stillage disposal sites are located on relatively permeable soils. Where the available land for application of stillage is such that the limiting permeability is slow to moderately slow, the use of slow rate irrigation may be used as an alternative to rapid infiltration. The application depends on the expected evaporation and infiltration and can range from less than 0.5 to 1.5 inches (13,600 to 40,000 gal/acre). Resting periods should range from 18 to 20 days or more. The resultant average loading rates and land areas are shown in Table IV-1. All other disposal site requirements and operational procedures for the rapid infiltration method also apply to the slow rate irrigation method.

| Table IV-1  
Slow Rate Irrigation Area Requirements |
|----------------------------------------|

<table>
<thead>
<tr>
<th>Soil Permeability Rate</th>
<th>Slow (day loam)</th>
<th>Moderately Slow (day loam or silt loam)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limiting soil permeability, in/hr</td>
<td>0.06-0.2</td>
<td>0.2-0.6</td>
</tr>
<tr>
<td>Infiltration capacity, in/day</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Resting period, days</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Average loading rate, gal/acre/day</td>
<td>670</td>
<td>1,940</td>
</tr>
<tr>
<td>Area required per 100,000 gal/day of stillage, acres</td>
<td>150</td>
<td>52</td>
</tr>
</tbody>
</table>

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regulated with individual, site-specific NPDES permits. The Regional Water Board will issue waste discharge requirements on the discharge of urban runoff to land when a threat to water quality exists.

- Combined sewer systems will not be allowed without satisfactory justification.
- The Regional Water Board will require source control programs by local agencies when water quality benefits will be realized.
- Governing agencies should provide facilities for the treatment (if necessary), storage and percolation of runoff.

**Hazardous and Non-Hazardous Waste Disposal**

Discharges of solid, semi-solid, and liquid wastes to landfills, waste piles, surface impoundments, pits, trenches, tailings ponds, natural depressions, and land treatment facilities (collectively called "waste management units") have the potential to become sources of pollution affecting the quality of waters of the state. Unlike surface waters which often have the capacity to assimilate discharged waste constituents, ground waters have little or no assimilative capacity due to their slow migration rate, lack of aeration, lower biological activity, and laminar flow patterns. If concentrations of pollutants in land-discharged waste are sufficiently high to prevent the waste from being classified as "inert waste" under Title 23, California Code of Regulations, Section 2524, discharges of such wastes to waste management units require long-term containment or active treatment following the discharge in order to prevent waste or waste constituents from migrating to and impairing the beneficial uses of waters of the state. Pollutants from such discharges may continue to affect water quality long after the discharge of new waste to the unit has ceased, either because of continued leachate or gas discharges from the unit, or because pollutants have accumulated in underlying soils from which they are gradually released to ground water.

trenches, and soil depressions have been used in the past for liquid waste disposal. Mining waste management units (tailings ponds, surface impoundments, and waste piles) also represent a significant portion of the waste management units in the Region. The Regional Water Board issues waste discharge requirements to ensure that these discharges are properly contained to protect the Region's water resources from degradation, and to ensure that dischargers undertake effective monitoring to verify continued compliance with requirements.

These discharges, and the waste management units at which the wastes are discharged, are subject to concurrent regulation by other state and local agencies responsible for land use planning, solid waste management, and hazardous waste management. "Local Enforcement Agencies" (mainly cities and counties) implement the state's solid waste management laws and local ordinances governing the siting, design, and operation of solid waste disposal facilities (usually landfills) with the concurrence of the California Integrated Waste Management Board (Waste Management Board). The Waste Management Board also has direct responsibility for review and approval of plans for closure and post-closure maintenance of solid waste landfills. The Department of Toxic Substance Control issues permits for all hazardous waste treatment, storage, and disposal facilities (which include hazardous waste incinerators, tanks, and warehouses where hazardous wastes are stored in drums as well as landfills, waste piles, surface impoundments, and land treatment units). The State Water Board, regional water boards, Waste Management Board, and Department of Toxic Substances Control have entered into Memoranda of Understanding to coordinate their respective roles in the concurrent regulation of these discharges.

The statutes and regulations governing the discharges of both hazardous and non-hazardous wastes have been revised and strengthened in the last few years. The discharge of municipal solid wastes to land are closely regulated and monitored; however, some water quality problems have been detected and are being addressed. Solid waste water quality assessment tests and recent monitoring efforts under the State and regional water boards' Chapter 15 have revealed that discharges of municipal solid wastes to unlined landfills have resulted in ground water degradation and pollution by volatile organic constituents and other waste constituents. Volatile organic constituents are components of many household hazardous wastes and certain industrial wastes that are present within municipal solid waste streams. Volatile organic constituents can easily migrate from...
landfills either in leachate or by vapor-phase transport. Clay liners and natural clay formations between discharged wastes and ground waters are largely ineffective in preventing water quality impacts from municipal solid waste constituents. In a recently adopted policy for water quality control, the State Water Board found the "[r]esearch on liner systems for landfills indicates that (a) single clay liners will only delay, rather than preclude, the onset of leachate leakage, and (b) the use of composite liners represents the most effective approach for reliably containing leachate and landfill gas." [State Water Board Resolution No. 93-62, Policy for Regulation of discharges of Municipal Solid Waste]

As a result of similar information on a national scale, the U.S. Environmental Protection Agency (USEPA) adopted regulations under Subtitle D of the Resource Conservation and Recovery Act (RCRA) which require the containment of municipal solid wastes by composite liners and leachate collection systems. Composite liners consist of a flexible synthetic membrane component placed above and in intimate contact with a compacted low-permeability soil component. This liner system enhances the effectiveness of the leachate collection and removal system and provides a barrier to vapor-phase transport of volatile organic constituents from the unit. Regional water boards and the Waste Management Board are implementing these new regulations in California under a policy for water quality control from the State Water Board (Resolution No. 93-62) and regulations from the Waste Management Board. The State Water Board is in the process of developing revised regulations under Title 23, California Code of Regulations, Division 3, Chapter 15, Discharges of Waste to Land, to fully implement water quality-related portions of the RCRA, Subtitle D federal regulations.

Inert waste does not contain hazardous waste or soluble pollutants at concentrations in excess of applicable water quality objectives and does not contain significant quantities of decomposable waste. Some examples of inert wastes include: concrete rubble and excess clean earth fill. Inert wastes do not necessarily need to be disposed of at classified waste management units, but waste discharge requirements may be issued for their discharge at the discretion of the Regional Water Board.

**Other Discharge Activities**

Some remaining discharges of concern include small hydroelectric facility development, dredging and dredging spoils runoff.

The energy crisis of the 1970s resulted in a surge of small hydroelectric facility development in the mountains and foothills. Impairments to beneficial uses may occur from this type of stream development because of erosion from construction and changes in water temperature. The Regional Water Board has published guidelines for small hydroelectric facilities (see Appendix 31, which is included by reference into this plan) to help address some of the problems associated with small hydroelectric plants.

Dredging can result in turbidity and the reintroduction and resuspension of harmful metal or organic materials. This latter effect occurs directly as a result of the displacement of sediment at the dredging site and indirectly as a result of erosion of dredge spoil to surface waters at the deposition site. The Regional Water Board currently regulates dredging operations on a case-by-case basis. Operational criteria may result from permits or the water quality certification requirements stemming from Section 401(e) of the Clean Water Act. The opportunity may exist to regulate certain of the dredging operations under a general permit.

The Regional Water Board receives notice of spills, leaks, and overflows as they occur. These incidents are evaluated for water quality impacts and remedial actions are implemented when necessary.

**THE NATURE OF CONTROL ACTIONS IMPLEMENTED BY THE REGIONAL WATER BOARD**

The nature of actions to achieve water quality objectives are the following:

1. identifying potential water quality problems;
2. confirming and characterizing water quality problems through assessments of source, frequency, duration, extent, fate, and severity;
3. remedying water quality problems through imposing or enforcing appropriate measures;
4. monitoring problem areas to assess effectiveness of the remedial measures.

Generally, the actions associated with the first step consist of surveys or reviews of survey information and other data sources to isolate possible impairments of beneficial uses or water quality.

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The characterization step usually involves studies that attempt to answer questions about a water quality problem's source, extent, duration, frequency, and severity. Information on these parameters is essential to confirm a problem and prepare for remedy. The Regional Water Board may gain this information through its own work or through data submittals requested of actual or potential dischargers under Section 13267 of the California Water Code.

Problem remedy calls for the Regional Water Board to prevent or cleanup problems. A common means of prevention, as well as protection, of water quality is through the issuance of NPDES permits, waste discharge requirements, discharge prohibitions, or other discharge restrictions. The NPDES is a requirement of the Federal Clean Water Act (Section 402) and California has implementing responsibility. The national permit system only applies to certain surface water discharges. Waste discharge requirements, which encompass permits, are described in the Water Code Section 13260, et seq. The waste discharge requirements system is not as restricted as the federal NPDES.

Waste discharge requirements may be used to control any type of discharge to land, ground waters or surface waters that may affect water quality. The Regional Water Board considers existing quality of receiving waters; historical, present, and future beneficial uses and the rates of use; nature and character of the discharge and possible affect on beneficial uses and receiving water quality; particular impact on beneficial uses within the immediate area of the discharge; and water quality objectives. The Regional Water Board will make a finding as to all beneficial uses within the area of influence of the discharge, and will set waste discharge requirements to protect these uses while not allowing the discharge to violate receiving water quality objectives.

Cleanup is implemented through enforcement measures such as cease and desist and cleanup and abatement orders. Cease and desist orders and cleanup and abatement orders are two of the enforcement tools available to the Regional Water Board to correct actual or potential violations of waste discharge requirements, NPDES permits, prohibitions, and nuisance or pollution.

The details of the monitoring step are explained in Chapter VI. In general, the Regional Water Board has wide latitude to require actual and potential dischargers to submit monitoring and surveillance information, in addition to collecting its own or using State Water Board data.

Whatever actions that the Regional Water Board implements must be consistent with the Basin Plan’s beneficial uses and water quality objectives, as well as certain State and Regional Water Boards’ policies, plans, agreements, prohibitions, guidance, and other restrictions or requirements. These considerations are described in Chapter V and included in the Appendix when noted.

Antidegradation

The antidegradation directives of State Water Board Resolution No. 68-16 (Appendix 2) require that high quality waters of the State be maintained “consistent with the maximum benefit to the people of the State.” The Regional Water Board applies these directives when issuing a permit, or in an equivalent process, regarding any discharge of waste which may affect the quality of surface or ground waters in the region.

No proven means exist at present that will allow ongoing human activity in the Basin and maintain ground water salinity at current levels throughout the Basin. Consistent with the above, the Regional Water Board has determined that controlled ground water degradation by salinity is the most feasible and practical short-term management alternative for the Tulare Lake Basin. The water quality objectives for ground water salinity control the rate of increase and maintain beneficial uses as long as possible. A valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin.

Implementation of this policy to prevent or minimize surface and ground water degradation is a high priority for the Board. In nearly all cases, preventing pollution before it happens is much more cost-effective than cleaning up pollution after it has occurred. Once degraded, surface water is often difficult to clean up when it has passed downstream. Likewise, cleanup of ground water is costly and lengthy due, in part, to its relatively low assimilative capacity and inaccessibility. The prevention of degradation is, therefore, an important strategy to meet the policy’s objectives.

The Regional Water Board will apply the directives of Resolution No. 68-16 in considering whether to allow a certain degree of degradation to occur or remain. In conducting this type of analysis, the Regional Water Board will evaluate the nature of any proposed, existing, or materially changed discharge, that could affect the quality of waters within the region. Any discharge of waste to high quality waters must apply best practicable treatment or control not only to
been able to adopt numerical water quality objectives for constituents or parameters, and instead has adopted narrative water quality objectives (e.g., for bacteria, chemical constituents, taste and odor, and toxicity). Where compliance with these narrative objectives is required (i.e., where the objectives are applicable to protect specified beneficial uses), the Regional Water Board will, on a case-by-case basis, adopt numerical limitations in orders which will implement the narrative objectives.

To evaluate compliance with the narrative water quality objectives, the Regional Water Board considers, on a case-by-case basis, direct evidence of beneficial use impacts, all material and relevant information submitted by the discharger and other interested parties, and relevant numerical criteria and guidelines developed and/or published by other agencies and organizations (e.g., State Water Board, California Department of Health Services, California Office of Environmental Health Hazard Assessment, California Department of Toxic Substances Control, University of California Cooperative Extension, California Department of Fish and Game, U. S. EPA, U. S. Food and Drug Administration, National Academy of Sciences, U. S. Fish and Wildlife Service, Food and Agricultural Organization of the United Nations). In considering such criteria, the Board evaluates whether the specific numerical criteria, which are available through these sources and through other information supplied to the Regional Water Board, are relevant and appropriate to the situation at hand and, therefore, should be used in determining compliance with the narrative objective.

For example, compliance with the narrative objective for taste and odor may be evaluated by comparing concentrations of pollutants in water with numerical taste and odor thresholds that have been published by other agencies. This technique provides relevant numerical limits for constituents and parameters which lack numerical water quality objectives. To assist dischargers and other interested parties, the Regional Water Board staff has compiled many of these numerical water quality criteria from other appropriate agencies and organizations in the Central Valley Regional Water Board’s staff report, A Compilation of Water Quality Goals. This staff report is updated regularly to reflect changes in these numerical criteria.

Where multiple toxic pollutants exist together in water, the potential for toxicologic interactions exists. On a case by case basis, the Regional Water Board will evaluate available receiving water and effluent data to determine whether there is a reasonable potential for interactive toxicity. Pollutants which are carcinogens or which manifest their toxic effects on the same organ systems or through similar mechanisms will generally be considered to have potentially additive toxicity. The following formula will be used to assist the Regional Water Board in making determinations:

\[
\Sigma \left( \frac{\text{Concentration of Toxic Substances}}{\text{Toxicologic Limit for Substance in Water}} \right) < 1.0
\]

The concentration of each toxic substance is divided by its toxicologic limit. The resulting ratios are added for substances having similar toxicologic effects and, separately, for carcinogens. If such a sum of ratios is less than one, an additive toxicity problem is assumed not to exist. If the summation is equal to or greater than one, the combination of chemicals is assumed to present an unacceptable level of toxicologic risk. For example, monitoring shows that ground water beneath a site has been degraded by three volatile organic chemicals, A, B, and C, in concentrations of 0.3, 0.4, and 0.04 µg/l, respectively. Toxicologic limits for these chemicals are 0.7, 3, and 0.06 µg/l, respectively. Individually, no chemical exceeds its toxicologic limit. However, an additive toxicity calculation shows:

\[
\frac{0.3}{0.7} + \frac{0.4}{3} + \frac{0.04}{0.06} = 1.2
\]

The sum of the ratios is greater than unity (> 1.0); therefore, the additive toxicity criterion has been violated. The concentrations of chemicals A, B, and C together present a potentially unacceptable level of toxicity.

Where the Regional Water Board determines it is infeasible to achieve immediate compliance with water quality objectives adopted by the Regional Water Board or the State Water Board, or with water quality criteria adopted by the federal Environmental Protection Agency, or with an effluent limitation based on these objectives or criteria, the Regional Water Board shall establish in NPDES permits a schedule of compliance. The schedule of compliance shall include a time schedule for completing specific actions that demonstrate reasonable progress toward the attainment of the objectives or criteria and shall contain a final compliance date, based on the shortest practicable time required to achieve compliance. In no event shall an NPDES permit include a schedule of compliance that allows more than ten years (from the date of adoption of the objective or criteria) for compliance with water quality objectives, criteria or effluent limitations based on the objectives or criteria.

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Schedules of compliance are authorized by this provision only for those water quality objective or criteria adopted after the effective date of this provision. In accordance with Title 23, California Code of Regulations, Section 2231, compliance schedules may be included in waste discharge requirements for discharges other than from point sources to navigable waters.

For permitting purposes, it is important to clearly define how compliance with the narrative toxicity objectives will be measured. Staff is currently working with the State Water Board to develop guidance on this issue.

**Ground Water Cleanups**

The Regional Water Board's strategy for managing contaminated sites is guided by several important principles, which are based on Water Code Sections 13000 and 13304, the Chapter 15 regulations and State Water Board Resolution No. 92-49:

1. **State Water Board Policy and Regulation**
   
The Regional Water Board will require conformance with the provisions of State Water Board Resolution No. 68-16 in all cases and will require conformance with applicable or relevant provisions of Title 23, California Code of Regulations, Division 3, Chapter 15 to the extent feasible. These provisions direct the Regional Water Board to ensure that dischargers are required to cleanup and abate the effect of discharges in a manner that promotes attainment of background water quality, or the highest water quality which is reasonable and protective of beneficial uses if background levels of water quality cannot be restored.

2. **Site Investigation**
   
An investigation of soil and ground water to determine full horizontal and vertical extent of pollution is necessary to ensure that cleanup plans are protective of water quality. The goal of the investigation shall be to determine where concentrations of constituents of concern exceed beneficial use protective levels (water quality objectives) and, additionally, where constituents of concern exceed background levels (the zero-impact line). Investigations shall extend off-site as necessary to determine the full extent of the impact.

3. **Source Removal/Containment**
   
Immediate removal or containment of the source, to the extent practicable, should be implemented where necessary to prevent further spread of pollution as well as being among the most cost-effective remediation actions. The effectiveness of ground water cleanup techniques often depends largely on the completeness of source removal or containment efforts (e.g., removal of significantly contaminated soil or pockets of dense non-aqueous phase liquids).

4. **Cleanup Level Approval**
   
Ground water and soil cleanup levels are approved by the Regional Water Board through the adoption of enforcement orders or waste discharge requirements. The Executive Officer may approve cleanup levels as appropriately delegated by the Regional Water Board.

5. **Site Specificity**
   
Given the extreme variability of hydrogeologic conditions in the Region, cleanup levels must reflect site specific factors.

6. **Discharger Submittals**
   
The discharger must submit the following information for consideration by the Regional Water Board in establishing cleanup levels which meet the criteria contained in Title 23, California Code of Regulations, Section 2550.4(c) through (g):

   a. water quality assessment to determine impacts and threats to the quality of water resources;
   
b. risk assessment to determine impacts and threats to human health and the environment; and
   
c. feasibility study of cleanup alternatives which compare effectiveness, cost, and time to achieve cleanup levels. Cleanup levels covered by this study shall include, at a minimum, background levels, levels which meet all applicable water quality objectives and which do not pose significant risks to health or the environment, and an alternate cleanup level which is above background levels and which also meets the requirements as specified in paragraphs 7.e. and f. below.

7. **Ground Water Cleanup Levels**

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Ground water cleanup levels shall be established based on:

a. background concentrations of individual pollutants;

b. applicable water quality objectives to protect designated beneficial uses of the water body, as listed in Chapters II and III;

c. concentrations which do not pose a significant risk to human health or the environment, considering risks from toxic constituents to be additive across all media of exposure and, in the absence of scientifically valid data to the contrary, additive for all constituents having similar toxicologic effects or having carcinogenic effects; and

d. technologic and economic feasibility of attaining background concentrations and of attaining concentrations lower than defined by b and c, above.

e. Pursuant to Title 23, California Code of Regulations, the Regional Water Board establishes cleanup levels that are protective of human health, the environment and beneficial uses of waters of the state, as measured by compliance with b and c, above, and are equal to background concentrations if background levels are technologically or economically feasible to achieve. If background levels are infeasible to achieve, cleanup levels are set between background concentrations and concentrations that meet all criteria in b and c, above. Within this concentration range, cleanup levels must be set at the lowest concentrations that are technologically and economically achievable. In no case are cleanup levels established below natural background concentrations.

f. Technologic feasibility is determined by the availability of technologies which have been shown to be effective in reducing the concentrations of the constituents of concern to the established cleanup levels. Bench-scale and/or pilot-scale studies may be necessary to make this feasibility assessment in the context of constituent, hydrogeologic, and other site-specific factors. Economic feasibility does not refer to the subjective measurement of the ability of the discharger to pay the costs of cleanup, but rather to the objective balancing of the incremental benefit of attaining more stringent levels of constituents of concern as compared with the incremental cost of achieving those levels. Factors to be considered in the establishment of cleanup levels greater than background are listed in Title 23, California Code of Regulations, Section 25504(d). The discharger's ability to pay is one factor to be considered in determining whether the cleanup level is reasonable. However, availability of economic resources to the discharger is primarily considered in establishing reasonable schedules for compliance with cleanup levels.

g. Compliance with c, above, shall be determined through risk assessments, performed by the discharger, using procedures consistent with those used by the Department of Toxic Substances Control, the Office of Environmental Health Hazard Assessment, and the USEPA. The Regional Water Board is not the lead agency for specifying risk assessment procedures or for reviewing risk assessments. The Board will assist the discharger, as necessary, in obtaining the appropriate, most current procedures from the above listed agencies. To prevent duplication of effort, the Regional Water Board will rely on the Department of Toxic Substances Control, the Office of Environmental Health Hazard Assessment, or appropriately designated local health agencies to review and evaluate the adequacy of such risk assessments.

8. Compliance with Ground Water Cleanup Levels

To protect potential beneficial uses of the water resource as required by Water Code Sections 13000 and 13241, compliance with ground water cleanup levels must occur throughout the pollutant plume.

9. The Regional Water Board may consider modifying site-specific ground water cleanup levels (that have been determined pursuant to subsection 7, above) that are more stringent than applicable water quality objectives, only when a final remedial action plan has been pursued in good faith, and all of the following conditions are met:

a. Modified cleanup levels meet the conditions listed in 7b and c, above.

b. An approved cleanup program has been fully implemented and operated for a period of
time which is adequate to understand the hydrogeology of the site, pollutant dynamics, and the effectiveness of available cleanup technologies;

c. Adequate source removal and/or isolation is undertaken to eliminate or significantly reduce future migration of constituents of concern to ground water;

d. The discharger has demonstrated that no significant pollutant migration will occur to other underlying or adjacent aquifers;

e. Ground water pollutant concentrations have reached asymptotic levels using appropriate technology;

f. Optimization of the existing technology has occurred and new technologies have been evaluated and applied where economically and technologically feasible; and

g. Alternative technologies for achieving lower constituent levels have been evaluated and are inappropriate or not economically feasible.

10. Soil Cleanup Levels

For soils which threaten the quality of water resources, soil cleanup levels should be equal to background concentrations of the individual leachable/mobile constituents, unless background levels are technologically or economically infeasible to achieve. Where background levels are infeasible to achieve, soil cleanup levels are established to ensure that remaining leachable/mobile constituents of concern will not threaten to cause ground water to exceed applicable ground water cleanup levels, and that remaining constituents do not pose significant risks to health or the environment. The Regional Water Board will consider water quality, health, and environmental risk assessment methods, as long as such methods are based on site-specific field data, are technically sound, and promote attainment of all of the above principles.

11. Verification of Soil Cleanup

Verification of soil cleanup generally requires verification sampling and follow-up ground water monitoring. The degree of required monitoring will reflect the amount of uncertainty associated with the soil cleanup level selection process.

Follow-up ground water monitoring may be limited where residual concentrations of leachable/mobile constituents in soils are not expected to impact ground water quality.

12. Remaining Constituents

Where leachable/mobile concentrations of constituents of concern remain onsite in concentrations which threaten water quality, the Regional Water Board will require implementation of applicable provisions of Chapter 15. Relevant provisions of Chapter 15 which may not be directly applicable, but which address situations similar to those addressed at the cleanup site will be implemented to the extent feasible, in conformance with Title 23, California Code of Regulations, Section 2511(d). This may include, but is not limited to, surface or subsurface barriers or other containment systems, pollutant immobilization, toxicity reduction, and financial assurances.

Dilution

Neither surface nor ground waters shall be used to dilute wastes for the primary purpose of meeting waste discharge requirements, where reasonable methods for treating the wastes exist. Blending of wastewater with surface or ground water to promote beneficial reuse of wastewater in water short areas may be allowed where the Regional Water Board determines such reuse is consistent with other regulatory policies set forth or referenced herein.

Prohibitions

The Porter-Cologne Water Quality Control Act allows the Regional Water Board to prohibit certain types of discharges or discharges to certain waters (California Water Code, Section 13243). Prohibitions may be revised, rescinded, or adopted as necessary. The prohibitions applicable to the Tulare Lake Basin are identified and described below.

Leaching Systems

Discharge of wastes from new and existing leaching and percolation systems in the following areas is prohibited:

Corcoran Fringe Area, Kings County (Order No. 77-224)
East Porterville Area, Tulare County (Order No. 75-069)
Home Garden Community Services District, Kings County (Order No. 77-20)
Kettleman City Community Service Area No. 1, Kings County (Order No. 75-071)

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In addition, county moratoria prohibit new septic tank disposal systems in the following areas:

Del Rio, Fresno County
Delft Colony, Tulare County
El Rancho, Tulare County
Lindcove, Tulare County
Poplar, Tulare County
Seville, Tulare County
Toriyville, Tulare County
Tooleville, Tulare County
Traver, Tulare County
Wells Tract, Tulare County
Yettem, Tulare County

Petroleum

The discharge of oil or any residuary product of petroleum to the waters of the State, except in accordance with waste discharge requirements or other provisions of Division 7, California Water Code, is prohibited.

Hazardous Waste

Any discharge that may affect water quality of hazardous waste or chemicals known to cause cancer or reproductive toxicity, except in accordance with waste discharge and other federal, state, and local requirements.

Water Quality Limited Segments (WQLSs)

WQLSs are those sections of lakes, streams, rivers or other fresh water bodies where water quality does not meet (or is not expected to meet) water quality standards even after the application of appropriate effluent limitations for point sources [40 CFR 130, et seq.].

Additional treatment beyond minimum federal requirements will be imposed on dischargers to a WQLS. Point source dischargers will be assigned or allocated a maximum allowable load of critical pollutants. If necessary, nonpoint source discharges will be identified and reduction goals will be developed for these sources.

The list of WQLSs is contained in Appendix Item 33.

Water Quality Assessment

A second list of water bodies comprises the Water Quality Assessment. The Assessment describes the condition of water bodies within the Tulare Lake Basin to the best of the Regional Water Board’s knowledge. For water bodies with impairments (actual or suspected), a fact sheet is prepared to describe the Regional Water Board’s actions or proposed actions and to estimate the costs to correct the impairments. The Assessment is updated periodically on an as-needed basis.

Waivers

State law allows Regional Water Boards to waive waste discharge requirements for a specific discharge or types of discharges where it is not against the public interest [California Water Code, Section 13269]. However, NPDES permits for discharge to surface waters may not be waived.

On 26 March 1982, the Regional Water Board adopted Resolution No. 82-036 to waive waste discharge requirements for certain discharges. The types of discharges and the limitations on the discharges which must be maintained if the waivers are to apply are shown in Table IV-2. These waivers are conditional and may be terminated at any time.

The Regional Water Board may, after compliance with the California Environmental Quality Act (CEQA), allow short-term variances from Basin Plan provisions, if determined to be necessary to implement control measures for vector and weed control, pest eradication, or fishery management which are being conducted to fulfill statutory requirements under California’s Fish and Game, Food and Agriculture, or Health and Safety Codes. In order for the Regional Water Board to determine if a variance is appropriate, agencies proposing such activities must submit to the Regional Water Board project-specific information, including measures to mitigate adverse impacts.

**ACTIONS RECOMMENDED FOR IMPLEMENTATION BY OTHER AGENCIES**

Consistent with the Porter-Cologne Water Quality Control Act, the Basin Plan may identify control actions recommended for implementation by agencies other than the Regional Water Board [California Water Code, Section 13242(a)].

**Irrigated Agriculture**

The water quality concerns from irrigated agriculture are great and the Regional Water Board cannot resolve
<table>
<thead>
<tr>
<th>TYPE OF WASTE DISCHARGE</th>
<th>LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conditioner, cooling and elevated temperature waters</td>
<td>Small volumes which will not change temperature of receiving water more than 1 degree C.</td>
</tr>
<tr>
<td>Drilling muds</td>
<td>Discharged to a sump with two feet of freeboard. Sump must be dried by evaporation or pumping. Drilling-mud may remain in sump only if discharger demonstrates that it is nontoxic. Sump area shall be restored to pre-construction state within 60 days of completion or abandonment of well.</td>
</tr>
<tr>
<td>Clean oil containing no toxic materials</td>
<td>Used for beneficial purposes such as dust control, weed control and mosquito abatement where it cannot reach state waters.</td>
</tr>
<tr>
<td>Minor dredger operations</td>
<td>When soil is nontoxic and discharged to land.</td>
</tr>
<tr>
<td>Inert solid wastes (per CCR, Section 2524)</td>
<td>Good disposal practices.</td>
</tr>
<tr>
<td>Test pumpings of fresh water wells.</td>
<td>When assurances are provided that pollutants are neither present nor added.</td>
</tr>
<tr>
<td>Storm water runoff</td>
<td>Where no water quality problems are contemplated and no federal NPDES permit is required.</td>
</tr>
<tr>
<td>Erosion from development</td>
<td>Where BMP plans have been formulated and implemented.</td>
</tr>
<tr>
<td>Pesticide rinse waters from applicators</td>
<td>Where discharger complies with Regional Water Board guidance.</td>
</tr>
<tr>
<td>Confined animal wastes</td>
<td>Where discharger complies with Regional Water Board guidance.</td>
</tr>
<tr>
<td>Minor stream channel alterations and suction dredging</td>
<td>Where regulated by Department of Fish and Game agreements.</td>
</tr>
<tr>
<td>Small, short-term sand and gravel</td>
<td>All operations and wash waters confined to land.</td>
</tr>
<tr>
<td>Small, metal mining operations</td>
<td>All operations confined to land, no toxic materials utilized in recovery operations.</td>
</tr>
<tr>
<td>Swimming pool discharges</td>
<td>Where adequate dilution exists or where beneficial uses are not affected.</td>
</tr>
<tr>
<td>Food processing wastes spread on land</td>
<td>Where an operating/maintenance plan has been approved.</td>
</tr>
<tr>
<td>Construction</td>
<td>Where BMPs are used.</td>
</tr>
<tr>
<td>Agricultural commodity wastes</td>
<td>Small, seasonal and confined to land.</td>
</tr>
<tr>
<td>Industrial wastes utilized for soil amendments</td>
<td>Where industry certifies its nontoxic content and BMPs are used for application.</td>
</tr>
<tr>
<td>Timber harvesting</td>
<td>Operating under an approved timber harvest plan.</td>
</tr>
<tr>
<td>TYPE OF WASTE DISCHARGE</td>
<td>LIMITATIONS</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Minor hydro projects</td>
<td>Operating under water rights permit from State Water Resources Control Board or Department of Fish and Game agreement and no water quality impacts anticipated.</td>
</tr>
<tr>
<td>Irrigation return water (tail-water)</td>
<td>Operating to minimize sediment to meet Basin Plan turbidity objectives and to prevent concentrations of materials toxic to fish or wildlife.</td>
</tr>
<tr>
<td>Projects where application for Water Quality Certification is required</td>
<td>Where project (normally minor construction) is not expected to have a significant water quality effect and project complies with Dept. of Fish and Game agreements.</td>
</tr>
<tr>
<td>Septic tank/leachfield systems</td>
<td>Where project has county permit and county uses Water Board Guidelines.</td>
</tr>
</tbody>
</table>

these alone. The following actions should be taken by other agencies:

1. As a last resort and where the withholding of irrigation water is the only means of achieving significant improvements in water quality, the State Water Board should use its water rights authority to preclude the supplying of water to specific lands.

2. The State Water Board should require all water agencies in the Central Valley, regardless of size, to submit an “informational” report on water conservation.

3. The State Water Board should continue to declare the drainage problem in the Central Valley a priority nonpoint source problem in order to make EPA nonpoint source control funding available to the area.

4. The Legislature should sponsor additional bond issues before the voters to provide low interest loans for agricultural water conservation and water quality projects. The bonds should incorporate provisions that would allow recipients to be private landowners, and that would allow irrigation efficiency improvement projects that reduce drainage discharges to be eligible for both water conservation funds and water quality facilities funds.

5. The US Bureau of Reclamation should give the districts and growers subject to this program first priority in their water conservation loan program.

6. The State Water Board should request legislation that will protect negotiated fish flow releases for instream uses in those critical reaches designated by the Department of Fish and Game from any new exercise of appropriative or riparian rights. These flow releases should recognize and protect existing contractual commitments for beneficial use.

**Mining**

Agencies with jurisdiction over mineral rights should issue these rights for limited periods of time and distribute them to the Regional Water Board for review.

**Transfer of Water**

Before granting new permits for water storage or diversion which involves interbasin transfer of water, the State Water Board should require the applicant to evaluate the alternatives listed below. Permits should not be approved unless the alternatives have been thoroughly investigated and ruled out for social, environmental, or economic reasons.

1. Make optimum use of existing water resource facilities.

2. Store what would otherwise be surplus wet-weather basin outflows in off-stream reservoirs.

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the Lower Kings River. The result of these studies was proposed modifications to the implementation and the monitoring and surveillance portions of this plan. However, due to drought conditions, neither investigation was conclusive. Additional study will be necessary to adequately define the salinity problems and develop policy decisions.

II. Beneficial Uses of Surface Water: The Basin Plan designated beneficial uses for all streams in the Tulare Lake Basin but recognized that those uses needed to be modified when additional studies become available. Various agencies have information on uses which were not available in 1975. This information should be used to develop a new table of beneficial uses which accurately describes the individual streams.

III. Ground Water Monitoring Network to detect trends in water quality: The Basin Plan describes a ground water monitoring network for the Tulare Lake Basin. This network was never established. As more and more contaminants are found in the ground water, establishment of an effective monitoring system has become imperative.

IV. Ground Water Contamination: There are several areas within the Tulare Lake Basin where the ground water is adversely impacted by salts and chemicals to the extent that the ground water no longer supports all its beneficial uses. In some cases, the cause of the impact is identified and clean-up operations are proceeding. In most cases, the presence of the salts and chemicals are due to nonpoint source impacts and the source is not clear. Investigations should be done to identify potential sources of these contaminants and practices should be developed to reduce these impacts.

V. Ground Water Quality Objectives for Salinity: The Basin Plan contains water quality objectives for salinity increases in ground water. These objectives have never been studied to determine their adequacy in promoting the Board's goal of minimizing the rate of salinity increase in the Tulare Lake Basin. A study should be conducted to confirm the adequacy of the listed objectives.

VI. Dissolved Oxygen Objectives: The dissolved oxygen objective for Reach III of the Kings River (Pine Flat Dam to Friant-Kern) may not be achievable due to natural conditions. A study should be conducted to investigate this and establish more appropriate objectives, if necessary.

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V. PLANS AND POLICIES

In addition to this Basin Plan, statewide plans and policies adopted by the State Water Board direct Regional Water Board actions or clarify the Regional Water Board’s intent. Agreements between other agencies and either the State or Regional Water Board also affect Regional Water Board actions. All policies, plans, and agreements may be revised. Any revision will supersede the policies, plans, and agreements described below and found in the appendices.

State Water Board Policies and Plans

Eleven State Water Board water quality control policies and five State Water Board water quality control plans direct regional water board actions. Two of the policies (Policy for the Enclosed Bays and Estuaries of California, and the Pollutant Policy Document) and three of the plans (the Ocean Plan, the Delta Plan, and the Tahoe Plan) do not apply to the Tulare Lake Basin. The applicable policies and plans are described below.

1. The State Policy for Water Quality Control

   Adopted in 1972, this policy declares the State Water Board’s intent to protect water quality through the implementation of water resources management programs and serves as the general basis for subsequent water quality control policies. See Appendix 1.

2. State Water Board Resolution No. 68-16, Statement of Policy with Respect to Maintaining High Quality of Water in California

   This policy, adopted on 28 October 1968, is intended to maintain high quality waters. It establishes criteria the Regional Water Board must satisfy before allowing discharges that may reduce water quality of surface or ground waters even though such a reduction will still protect beneficial uses.

   Changes in water quality may be allowed only if the change is consistent with maximum benefit to the people of the State, does not unreasonably affect present and anticipated beneficial uses, and does not result in water quality less than that prescribed in water quality control plans and policies. U.S. EPA water quality standards regulations require each state to adopt an “antidegradation” policy and specify the minimum requirements for it (40 CFR 131.12). Although Resolution No. 68-16 preceded the federal policy, the State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy. Therefore, the federal antidegradation policy must be followed where it is applicable. The federal antidegradation policy applies if a discharge or other activity, which began after November 28, 1975, will lower surface water quality. Application of the federal policy may be triggered by water quality impacts or mass loading impacts to receiving waters. Appendix 2 contains Resolution No. 68-16, Appendix 26 contains the federal policy.

3. State Water Board Resolution No. 75-58, Water Quality Control Policy on the Use and Disposal of Inland Waters Used for Powerplant Cooling

   Adopted in June 1975, this policy prohibits discharge of blowdown waters to land unless in compliance with Title 23, California Code of Regulations, Chapter 15. The policy also prohibits the discharge of once through cooling water to surface waters unless existing water quality and aquatic resources can be maintained. Further, it sets forth seven principles that, among other things, establish higher priorities for use of water sources other than fresh inland waters. For the Tulare Lake Basin, the powerplant must investigate the feasibility of using wastewater for powerplant cooling. Regional water boards are directed to adopt requirements that contain mass emission rates that maintain existing water quality. See Appendix 3.

4. State Water Board Resolution No. 77-1, Policy and Action Plan for Water Reclamation in California

   This policy was adopted on 6 January 1977. Because reclamation provides an alternate source of water suitable for irrigation, reuse is encouraged by the State Water Board. The policy also encourages water conservation and calls for other agencies to assist in implementation. See is Appendix 4.

5. State Water Board Resolution No. 87-22, Policy on the Disposal of Shredder Waste

   This policy, adopted 19 March 1987, permits wastes produced by the mechanical destruction of
car bodies, old appliances and similar castoffs to be disposed of into certain landfills at the discretion of and under specific conditions designated and enforced by the Regional Water Board. See Appendix 5.

6. State Water Board Resolution No. 88-23, Policy Regarding Regulation of Underground Storage Tanks

This policy, adopted on 18 February 1988, implements a pilot program to fund oversight of remedial action at leaking underground storage tank sites, in cooperation with the California Department of Health Services. Oversight may be deferred to the regional water boards. See Appendix 6.

7. State Water Board Resolution No. 88-63, "Sources of Drinking Water" Policy

This policy, adopted on 19 May 1988, specifies that, except under specifically defined exceptions, all surface and ground waters are suitable or potentially suitable for MUN. The specific exceptions are for waters with existing high total dissolved solids concentrations (greater than 3,000 mg/l), aquifers with low sustainable yield (less than 200 gallons per day for a single well), water with contamination that cannot be treated for domestic use using best management practices or best economically achievable treatment practices, waters within particular municipal, industrial and agricultural wastewater conveyance and holding facilities, and regulated geothermal ground waters. Where the Regional Water Board finds that one of the exceptions applies, it may remove the MUN designation for the particular water body through a formal Basin Plan amendment which includes a public hearing. The exception becomes effective upon approval by the State Water Board and the Office of Administrative Law. See Appendix 7.


These policies and procedures, adopted 18 June 1992 and amended on 21 April 1994, describe the manner in which the Regional Water Board will require dischargers to cleanup and abate the effect of discharges. This cleanup and abatement shall be done in a manner that promotes attainment of background water quality, or the highest water quality which is reasonable if background levels of water quality cannot be restored. Any cleanup less stringent than background water quality shall be consistent with State Water Board Resolution No. 68-16. See Appendix 8.

9. State Water Board Resolution No. 93-62, Policy for Regulation of Discharges of Municipal Solid Waste

Adopted on 17 June 1993, this policy directs the Regional Water Board to amend waste discharge requirements for municipal solid waste landfills to incorporate pertinent provisions of the federal "Subtitle D" regulations under the Resource Conservation and Recovery Act (40 CFR Parts 257 and 258). Landfills which are subject to the Subtitle D regulations and this policy are those which accepted municipal solid waste on or after 9 October 1991. See Appendix 9.

10. The Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan)

This plan was adopted on 18 May 1972 and amended 18 September 1975. It specifies water quality objectives, effluent quality limits, and discharge prohibitions related to thermal characteristics of interstate waters and waste discharges. See Appendix 10.

11. State Water Board Resolution No. 88-123, Nonpoint Source Management Plan

This plan was adopted in 1988 and describes three general management approaches that are to be used to address nonpoint source problems. These are 1) voluntary implementation of best management practices, 2) regulatory based encouragement of best management practices, and 3) adopted effluent limits.

The approaches are listed in order of increasing stringency. In general the least stringent option that successfully protects or restores water quality should be employed, with more stringent measures considered if timely improvements in beneficial use protection are not achieved. The Regional Water Board will determine which approach or combination of approaches is most appropriate for any given nonpoint source problem.
problems, including spills associated with operators and/or new proposed oil field discharges. The agencies work together to review, prepare, and coordinate permits and enforcement. See Appendix 15.

6. Department of Health Services/Department of Toxic Substances Control

On 30 July 1990, the State Water Board signed a MOU with the Department of Health Services, Toxic Substances Control Program (later reorganized into the Department of Toxic Substances Control) explaining the roles of the agencies (including the Regional Water Board) in the cleanup of hazardous waste sites. The MOU describes the protocol the agencies will follow to determine which agency will act as lead and which will act as support, the responsibilities of the agencies in their respective roles, the procedures the agencies will follow to ensure coordinated action, the technical and procedural requirements which each agency must satisfy, the procedures for enforcement and settlement, and the mechanism for dispute resolution. This MOU does not alter the Regional Water Board’s responsibilities with respect to water quality protection. See Appendix 16.

7. Soil Conservation Service, U.S. Department of Agriculture

On 31 July 1990, the State Water Board signed a MOU with the Soil Conservation Service, now the Natural Resources Conservation Service, to develop appropriate guidelines and procedures to provide technical assistance on the management of nonpoint sources. See Appendix 17.


On 27 August 1990, the State Water Board signed a MOU with the Environmental Affairs Agency, Air Resources Board, and California Integrated Waste Management Board to enhance program coordination and reduce duplication of effort. This MOU consists of provisions describing the scope of the agreement (including definitions of the parties and issues to which the MOU applies), the principles which will govern the conduct of the parties, and the existing statutory framework. See Appendix 18.

9. California Department of Pesticide Regulation

On 23 December 1991, the State Water Board signed a MOU with the California Department of Pesticide Regulation to exchange information regarding pesticides in surface waters, develop water quality objectives to protect beneficial uses, and promote the identification and development of best management practices whenever necessary to protect beneficial uses. This agreement was revised on 19 January 1993 to facilitate implementation of the original agreement. See Appendix 19.

10. Implementation of the San Joaquin Valley Drainage Program’s Recommended Plan

In January 1992, the State Water Board signed a MOU with the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service, the U.S. Soil Conservation Service (now the Natural Resources Conservation Service), the U.S. Geological Survey, the Department of Water Resources, the Department of Fish and Game, and the Department of Food and Agriculture. Subject to the availability of funding and legal authority, these agencies agreed to use the management plan described in the September 1990 final report of the San Joaquin Valley Drainage Program as a guide for remediating subsurface agricultural drainage and related problems. See Appendix 20.

11. California Integrated Waste Management Board

On 8 January 1993, the State Water Board signed a MOU to address the Regional Water Board’s review of Solid Waste Assessment Test (SWAT) reports. See Appendix 21.

12. U.S. Bureau of Land Management

On 27 January 1993, the State Water Board signed a MOU to work cooperatively with the U.S. Bureau of Land Management to develop and implement best management practices to reduce or prevent nonpoint source pollution. See Appendix 22.

Regional Water Board General Policy

1. Regional Water Board Resolution No. 70-118, Delegation of Duties and Powers to the Regional Water Board’s Executive Officer

In January 1970, the Regional Water Board adopted Resolution No. 70-118, which delegates
certain duties and powers of the Board to its Executive Officer pursuant to Section 13223 of the California Water Code. See Appendix 23.

Regional Water Board Memoranda of Understanding (MOU)

1. U. S. Bureau of Land Management

In September 1985, the Regional Water Board Executive Officer signed an MOU with the U. S. Bureau of Land Management, Bakersfield District. The MOU aims at improving coordination between the two agencies for the control of water quality problems resulting from mineral extraction activities on BLM administered lands. See Appendix 24.

2. Department of Fish and Game and Mosquito Abatement and Vector Control Districts

In March 1993, the Regional Water Board Executive Officer signed an MOU with the Department of Fish and Game and Mosquito Abatement Districts in the southern San Joaquin Valley to coordinate weed control efforts in wastewater treatment facilities. See Appendix 25.
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ANNUAL REPORT
FOR
FACILITIES IN THE FEEDLOT CATEGORY REGULATED BY
STATEWIDE GENERAL PERMIT - WQ ORDER NO. 97-03-DWQ
NPDES NO.CAS000001

This report form is designed for use by facilities in the feedlot category that have submitted a Notice of Intent to comply with the General Permit for Discharges of Storm Water Associated with Industrial Activities (General Permit) and that qualify for a reduced monitoring program because the facility is operated in compliance with state water quality regulations.

Please provide the following information. Provide a brief explanation, on a separate sheet(s), to all questions you have answered with a “No” response, and to those questions that request additional information. Attach the extra pages to your report form.

This report must be signed by an appropriate official of your company (see Section C.9 and C.10 of the General Permit).

GENERAL OWNER/FACILITY INFORMATION

A. Facility WDID No.

B. Facility/Site Information:

Name:__________________________ County:__________________________

Street Address:_____________________________________________________

City:__________________________ State:____ Zip Code:____________________

Describe your business activities:

______________________________________________________________

______________________________________________________________

Mailing Address:_____________________________________________________

City:__________________________ State:____ Zip Code:____________________

Contact Person:__________________________ Phone Number:(   )__________

000888
1. Did you operate your facility in full compliance with Sections 22560 through 22565, Title 27, California Code of Regulations?  ____Yes  ____No

NOTE: If you answered No to this question, you do not qualify to use this simplified reporting form. Complete and return the standard annual report form.

2. Have you prepared a Storm Water Pollution Prevention Plan (SWPPP) as required in Section A of the General Permit?  ____Yes  ____No

3. Have you implemented all elements of your SWPPP?  ____Yes  ____No

4. Did you conduct monthly visual wet weather inspections of your wastewater containment facilities to detect leaks and ensure maintenance of adequate freeboard (Section B.4.d)  ____Yes  ____No

If Yes, please provide:
- Date and time of inspections. Include a sketch showing which parts of the facility were monitored.
- Observations made during the inspections. If discharges were observed, discuss any actions taken or to be taken to prevent future discharges.

5. Do you certify (as indicated below) that, based on your annual comprehensive site compliance evaluation, your facility is in compliance with the requirements of the General Permit and your SWPPP?  ____Yes  ____No

NOTE: Dischargers who cannot certify compliance and/or who have had other instances of noncompliance must notify the Regional Board. The notification shall identify the type(s) of noncompliance, a description of the actions necessary to achieve compliance, and a time schedule indicating when compliance will be achieved. Noncompliance notifications must be submitted within 30 days of identification of noncompliance.

CERTIFICATION:

I am a person duly authorized to sign reports required by the California General Permit for Storm Water Discharges Associated with Industrial Activities and I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

Printed Name:______________________________________________

Signature:_________________________________________ Date:__________

Title:________________________________________________
STATEWIDE WATER QUALITY REGULATIONS FOR DAIRIES

Subchapter 2. Confined Animals

Article 1. SWRCB - Confined Animal Facilities

§22560. SWRCB - Applicability. (Ch-15: §2560)
(a) General—This article prescribes statewide minimum standards for discharges of animal waste at confined animal facilities. These standards shall either be implemented in any WDRs issued for a particular animal waste facility or shall be made a condition to the waiver of such requirements.
(b) ROWD—A discharger required to submit a report of waste discharge shall provide the following general information and shall report any material changes as defined in Section 2210 of Title 23 of this code:
   (1) average daily volume of facility wastewater and volume or weight of manure;
   (2) total animal population at the facility, and types of animals;
   (3) location and size of use or disposal fields and retention ponds, including animal capacity; and
   (4) animal capacity of the facility.
(c) Regulations Are Minimum Standards—The RWQCB shall impose additional requirements, if such additional requirements are necessary to prevent degradation of water quality or impairment of beneficial uses of waters of the state.

§22561. SWRCB - General Standard For Surface Water. (Ch-15: §2561)
The discharger shall prevent animals at a confined animal facility from entering any surface water within the confined area.

§22562. SWRCB - Wastewater Management. (Ch-15: §2562)
(a) Design Storm (for Run-On/Run-Off Control)—Confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all precipitation on, and drainage through, manured areas during a 25-year, 24-hour storm.
(b) Manured Area Run-On Exclusion—All precipitation and surface drainage outside of manured areas, including that collected from roofed areas, and runoff from tributary areas during the storm events described in &a), shall be diverted away from manured areas, unless such drainage is fully retained. RWQCBs can waive application of such requirements only in specific instances where upstream land use changes have altered surface drainage patterns such that retention of flood flows is not feasible.
(c) Design Storm (for Flood Protection).
   (1) Retention ponds and manured areas at confined animal facilities in operation on or after November 27, 1984, shall be protected from inundation or washout by overflow from any stream channel during 20-year peak stream flows.
   (2) Existing facilities that were in operation on-or-before November 27, 1984, and that are protected against 100-year peak stream flows must continue to provide such protection. Facilities, or portions thereof, which begin operating after November 27, 1984, shall be protected against 100-year peak stream flows.
   (3) The determination of peak stream flows shall be from data provided by a recognized federal, state, local, or other agency.

1 From Title 27, Division 2, Subdivision 1, California Code of Regulations.
Statewide Water Quality Regulations for Dairies

(d) Retention Pond Design—Retention ponds shall be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or artificial materials of equivalent impermeability.

(c) Discharge To Disposal/Use Fields—The RWQCB shall allow the discharge of facility wastewater and of collected precipitation and drainage waters to use or disposal fields only if such discharge is in accordance with §18130. Absent an NPDES permit for discharge to surface waters, the only other allowable discharge is to wastewater treatment facilities approved by the RWQCB.

§22563 SWRCB - Use or Disposal Field Management. (Ch-15: §2563)
(a) Reasonable Soil Amendment Rate—Application of manure and wastewater to disposal fields or crop lands shall be at rates which are reasonable for the crop, soil, climate, special local situations, management system, and type of manure.
(b) Run-Off & Percolation—Discharges of facility wastewater to disposal fields shall not result in surface runoff from disposal fields and shall be managed to minimize percolation to ground water.

§22564 SWRCB - Management of Manured Areas. (Ch-15: §2564)
Manured areas shall be managed to minimize infiltration of water into underlying soils.

§22565 SWRCB - Monitoring. (Ch-15: §2565)
The RWQCB can require confined animal facility operations to undertake a monitoring program as a condition to the issuance or waiver of WDRs.
Federal law and regulations require that certain dairies have a National Pollutant Discharge Elimination System (NPDES) permit issued under the federal Clean Water Act. This fact sheet provides information to help you determine if your dairy must have an NPDES stormwater permit. In the discussion below, an "Animal Unit" (AU) is 1,000 pounds of animal(s), and "surface water" is a water of the state.

**Question:** What are the typical surface water quality problems associated with a dairy?

**Answer:** Wastewater from a dairy is high in nitrogen, ammonia, salts, and organic material (manure and other solids). When nitrogen and ammonia are discharged to a creek or stream, they can be poisonous to the plants and animals living in the waters. Organic material can reduce or remove the dissolved oxygen in a creek or stream, thereby suffocating the fish that live there. In addition, manure, like any other waste produced by warm-blooded animals, contains bacteria that could pose a threat to human health and/or sources of drinking water. Any of these pollutants, if discharged from a sewage treatment plant to surface water, would be regulated by an NPDES permit.

**Question:** When does a dairy need an NPDES stormwater permit?

**Answer:** A dairy is required to have an NPDES stormwater permit if it has the potential to discharge to surface water, and:

1. the dairy has over 1,000 AU (more than 700 or more milk and/or dry cows) confined or corralled for 45 or more days during any 12 months period, or
2. the dairy has 301 to 1,000 AU (200 to 700 milk and dry cows) and animal waste was discharged to surface water through a man-made conveyance (ditch, pipe, etc.), or was discharged into a surface water drainage course passing through the dairy (originating and ending outside the dairy), or
3. the dairy has been designated as a concentrated animal feeding operation (CAFO) by the Regional Water Quality Control Board (Regional Board) as a potential or actual significant contributor to pollution of surface waters.

**Question:** Can a dairy be exempt from obtaining an NPDES stormwater permit?

**Answer:** Regardless of herd size, a dairy does not need an NPDES stormwater permit if it is managed such that discharges to surface water occur only during storm events greater than the 25-year 24-hour storm event. (The 25-year 24-hour storm event is rainfall in a 24-hour period expected to occur once every 25 years.)

**Question:** How does a dairy operator determine the size of the 25-year 24-hour storm?

**Answer:** The National Oceanic and Air Administrator of the National Weather Service has determined the water amounts in a 25-year 24-hour storm. For example, in the San Joaquin Valley, the 25-year 24-hour storm will generate about 2.5 inches of rain. Contact your local weather service or the local office of the National Resources Conservation Service to obtain actual rainfall values for your area. County building and road departments also often have this information.
**Fact Sheet No. 1 For Dairies**

**Question:** How can a dairy operator determine whether the dairy qualifies for an exemption?

**Answer:** Many waste ponds may not be large enough to contain: (1) the runoff generated by the 25-year 24-hour storm event, (2) the runoff generated by rain prior to the 25-year 24-hour storm, and (3) any process wastewater generated on-site, and still maintain adequate freeboard in the ponds. If you have determined how much storage capacity you need to contain the 25-year 24-hour storm, previous rainfall runoff, and wastewater, and your pond system always has this much capacity with adequate freeboard, then you may qualify for an exemption.

**Question:** How is an NPDES stormwater permit obtained?

**Answer:** Contact the dairy regulatory staff at your Regional Board office listed below. They can assist you in determining what type of NPDES permit (stormwater or individual) is most appropriate for your dairy.

**Question:** If a dairy has an NPDES stormwater permit, what is it allowed to do during severe weather conditions?

**Answer:** The NPDES stormwater permit allows a properly operated dairy to discharge from its waste management system during periods of continuous rain or catastrophic events in order to prevent overtopping of the pond or other waste system failure. The discharge should cease as soon as conditions allow the waste to be retained on the dairy and associated cropland. Such a discharge by a dairy with an NPDES stormwater permit is not a violation of the federal Clean Water Act. Violators of the Clean Water Act are subject to fines up to $27,500 a day. They may also be sued by a third party for these violations.

**Example:** Dairy A has an NPDES permit and a waste handling system with the ability to collect and contain the volume of runoff expected to be generated by a 25-year 24-hour storm event. It rains heavily for three weeks (a chronic rainfall), but the rainfall in any 24-hour period never exceeds the 25-year 24-hour storm value. Dairy A's waste handling system reaches capacity and discharges to waters of the United States. That discharge is not considered a violation of the Clean Water Act.

Dairy B is identical to Dairy A, except that Dairy B does not have an NPDES stormwater permit. Dairy B's discharges to the waters of the United States during a chronic storm event would be a violation of the Clean Water Act with potential penalties up to $27,500 for each day of violation.

Even if a dairy is not required to have an NPDES stormwater permit, it may be in your best interest to have one. Also, dairy operators should be aware that in addition to the NPDES program they are subject to regulation under California's Water Code (see Fact Sheets No. 2 and No. 3 for Dairies). For further information, or to obtain an application for an NPDES permit (the General Industrial Stormwater Permit form), contact the Regional Board dairy regulatory staff at one of the following offices:

- Sacramento (916) 255-3000
- Fresno (559) 445-5116
- Redding (916) 224-4845
This fact sheet provides information on dairy waste management practices that comply with state and federal laws for protection of water quality (applicable state regulations are summarized on Page 2 of this Fact Sheet). Compliance with laws and regulations for management of animal waste at dairies is usually achieved through voluntary actions by the dairy owner/operator. Essentially, the regulations require that animal wastes be contained in an appropriate storage area until they are applied to cropland at a reasonable rate. The following information is provided to help clarify those requirements:

- "Animal wastes" includes animal manure and urine and materials that have mixed with manure and urine (for example, washwater from a milk barn, rainwater runoff that has passed through a manure storage area, and irrigation tailwater that contains manure). Runoff from a silage storage area is not animal waste, but is a waste that must also be contained and managed (it can be added to a dairy wastewater storage pond).

- An "appropriate storage area" means a facility designed to prevent animal wastes from contacting surface water or groundwater or moving off the dairy property. A holding pond that meets the construction standards in the California Code of Regulations, Title 27, Subdivision 1, Chapter 7, Subchapter 2, Article 1 is appropriate for long-term storage. The holding pond should be able to contain all wastewater and stormwater generated during the rainy season (approximately 120 days) plus a 25-year 24-hour storm. A ditch or field that is blocked off for storage of wastewater is only appropriate for short-term storage in an emergency. A concrete slab is an appropriate long-term manure storage area. Unpaved soil is only appropriate for short-term storage of wet manure such as might occur for a few days when solids are removed from a holding pond. A corral is not an appropriate wastewater storage area and should not have standing water for more than three days following a heavy rain.

- Application to cropland "at a reasonable rate" means that the amount of nutrients contained in the animal wastes do not exceed the amount required by the crop(s) where the wastes are applied. Furthermore, the application should occur when the crops will use the nutrients. The application rate should be specifically determined for each dairy. However, the basic rule is that the total amount of manure produced by five Holstein dairy cows is appropriate for one acre of double-cropped land (for example, land planted in oats and then in corn). If the ratio of cows to acres exceeds 5:1, then it is probably necessary to export manure solids and/or wastewater to other cropland. If wastewater is exported, it must be done with permission of the owner of the pipeline. In general, wastewater should be applied evenly to all available cropland at a dairy rather than limiting application to one area. The application of wastes to cropland must not result in tailwater runoff containing manure odor or color. Such tailwater will contain materials that are toxic to aquatic organisms and must be captured and reused instead of being allowed to enter an area drain.

The RWQCB may issue Waste Discharge Requirements (WDRs) for a dairy if it appears that waste management practices at the dairy can adversely impact water quality. The WDRs contain monitoring and reporting requirements including submission of annual reports to the RWQCB. Failure to submit required reports or comply with other requirements in WDRs can result in enforcement action by the RWQCB (see Fact Sheet No. 3 "Enforcement of Water Quality Laws And Regulations That Apply To Dairies" for additional information).
SUMMARY OF ANIMAL WASTE MANAGEMENT REGULATIONS  
(From California Code of Regulations, Subdivision 1, Chapter 7, Subchapter 2)

General Standards For Surface Water

The discharger shall prevent animals at a confined animal facility from entering any surface water within the confined area.

Wastewater Management

(a) Design Storm (for Run-On/Run-Off Control) - Confined animal facilities shall be designed and constructed to retain all facility wastewater generated, together with all prescription on, and drainage through, manured areas during a 25-year, 24-hour storm.

(b) Manured Area Run-On Exclusion - All precipitation and surface drainage outside of manured areas, including that collected from roofed areas, and runoff from tributary areas during the storm events described in part (a), shall be diverted away from manured areas, unless such drainage is fully retained. RWQCBs can waive application of such requirements only in specific instances where upstream land use changes have altered surface drainage patterns such that retention of flood flows is not feasible.

(c) Design Storm (for Flood Protection)

(1) Retention ponds and manured areas at confined animal facilities in operation on or after November 27, 1984, shall be protected from inundation or washout by overflow from any stream channel during 20-year peak stream flows.

(2) Existing facilities that were in operation on-or-before November 27, 1984 and that are protected against 100-year peak stream flows must continue to provide such protection. Facilities, or portions thereof, which begin operating after November 27, 1984 shall be protected against 100-year peak stream flows.

(3) The determination of peak stream flows shall be from data provided by a recognized federal, state, local, or other agency.

(d) Retention Pond Design - Retention ponds shall be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or be lined with artificial materials of equivalent impermeability.

(e) Discharge To Disposal/Use Fields - The RWQCB shall allow the discharge of facility wastewater and of collected precipitation and drainage waters to use or disposal fields only if such discharge is in accordance with the regulations in the following section titled "Use or Disposal Field Management". Other allowable discharge is to wastewater treatment facilities approved by the RWQCB.

Use or Disposal Field Management

(a) Reasonable Soil Amendment Rate - Application of manure and wastewater to disposal fields or crop lands shall be at rates which are reasonable for the crop, soil, climate, special local situations, management system, and type of manure.

(b) Run-Off & Percolation - Discharges of facility wastewater to disposal fields shall not result in surface runoff from disposal fields and shall be managed to minimize percolation to ground water.

Management of Manured Areas

Manured areas shall be managed to minimize infiltration of water into underlying soils.
The California Water Code (the Porter-Cologne Water Quality Control Act) requires that manure and other wastes be managed to protect water quality. State regulations that apply to dairies and other confined animal facilities have been established pursuant to the Water Code and are contained in the California Code of Regulations, Title 27, Subdivision 1, Chapter 7, Subchapter 2, Article 1 (see Fact Sheet for Dairies No. 2). Any dairy that causes a pollution of surface water or groundwater can be required to conduct an assessment of the body and clean up the pollution. In addition, the dairy operator and owner may be subject to fines if wastes are discharged off their property.

To ensure compliance with the Water Code, Regional Water Quality Control Boards (RWQCBs) can impose Waste Discharge Requirements for individual facilities. The RWQCBs can also take enforcement action by issuing a Notice of Violation, Cleanup and Abatement Order, Cease and Desist Order, or Administrative Civil Liability Complaint. These actions are described below.

Waste Discharge Requirements (WDRs) may be established after a dairy provides a Report of Waste Discharge (RWD) and pays a $2,000 filing fee. Dairies are usually requested to file a RWD only when it appears that waste management practices at the facility can adversely impact water quality. If review of the RWD indicates a waiver is appropriate, WDRs are not issued and a portion of the filing fee may be refunded. WDRs specify certain actions that must be met, prohibit other actions, and establish monitoring and reporting requirements including submission of annual reports to the RWQCB.

A Notice of Violation (NOV) can be issued to the operator and owner of any facility where wastes are discharged in violation of laws, regulations, or orders. The NOV will specify the problem that must be corrected and generally will require that a time schedule be established for necessary improvements. If the improvements are completed within the approved time schedule, the RWQCB generally does not assess oversight charges in conjunction with the NOV. If the problem is not corrected, and/or required information is not submitted, a RWQCB can initiate enforcement actions that may result in imposition of monetary penalties.

A Cleanup and Abatement (C&A) Order can be issued when wastes have been, or threaten to be, improperly discharged and corrective action is needed to protect water quality. The C&A Order will identify the discharge of concern and establish a schedule for corrective actions. The C&A Order may provide for reimbursement of RWQCB staff time to oversee corrective action. However, in cases where corrective actions are completed quickly, charges for staff time are minimal and may even be waived as not worth the administrative effort to collect.

A Cease and Desist (C&D) Order can be issued when Waste Discharge Requirements are violated. It is similar to a C&A Order in that it will specify the problem that must be corrected, will require that a time schedule be established for necessary improvements, and may provide for reimbursement for staff time. An ACL may be issued concurrently with a C&D Order.

An Administrative Civil Liability (ACL) is a monetary assessment issued to a facility that violates Waste Discharge Requirements or an enforcement order. The amount of the ACL is related to the violation that occurred up to a maximum of $25,000 for each day of occurrence. Failure to pay an ACL can result in referral to the Attorney General's office for prosecution.

In addition to the state laws and regulations enforced by the RWQCBs, there are state laws and regulations enforced by other state agencies such as the Department of Fish and Game. There are also federal laws and local regulations that apply to dairies. The most important federal laws are discussed below. The state and federal agencies that may be involved in enforcing compliance with the laws are also discussed below.
The Clean Water Act (CWA) is federal law established for protection of surface water, and is enforced by the USEPA and the RWQCBs. The CWA establishes the NPDES program (described in Fact Sheet No. 1 for Dairies) and provides for enforcement actions including fines of up to $27,500 per day of violation. The CWA allows for “third party” lawsuits under which part of a fine is given to the person reporting the violation.

The Safe Drinking Water Act is federal law established for protection of groundwater. The law is enforced by the USEPA, and sets allowable levels of specific chemicals, including nitrate, in drinking water supplies.

The following agencies are involved in protection of the environment and enforce state and/or federal laws and regulations that apply to the management and disposal of animal wastes:

State Department of Fish and Game (CDFG) This agency has regulations prohibiting discharges of waste that can adversely impact aquatic habitat. Any fines imposed for violation of CDFA regulations are in addition to any enforcement actions taken by the RWQCB or other regulatory agencies.

United States Environmental Protection Agency (USEPA) The USEPA enforces the Clean Water Act and the Safe Drinking Water Act and can impose fines for violation of those laws. Many dairies must obtain a federal NPDES storm water permit (please see Fact Sheet No. 1 For Dairies for more information on this subject). If a dairy does not have a NPDES storm water permit, and wastewater is discharged into a water course other that during a 25-year 24-hour storm, the USEPA can impose substantial fines. The fines imposed by USEPA are in addition to any enforcement actions taken by the RWQCB or other regulatory agencies.

County Health Departments Depending on the county, the local health department may have requirements for design and/or management of waste facilities at dairies. The county may be able to impose penalties for improper management of animal wastes or may refer cases to the county district attorney’s office for enforcement.

Attorneys and Special Prosecutors County District Attorneys, the California State Attorney General, attorneys from the U.S. Department of Justice, and other state and federal prosecutors can request courts to order corrections in waste management practices that do not comply with applicable federal, state, and local laws. The courts can also impose financial penalties for violations of those laws. In addition, the courts can impose criminal penalties, including a jail sentence, for certain violations. The orders and/or penalties imposed by state and federal courts can be in addition to any enforcement actions taken by the RWQCB or other regulatory agencies.

For more information about the water quality programs that apply to confined animal facilities, contact the RWQCB dairy regulatory staff at the following offices:

- Sacramento (916) 255-3000
- Fresno (559) 445-5116
- Redding (916) 224-4845
Question: What is a Nutrient and Irrigation Water Management Plan (NIWMP)?

Answer: A NIWMP is a written description of the procedures used to select and apply crop nutrients (manure and commercial fertilizers) and water to cropland, including pasture. The NIWMP includes a description of the process used to determine how much manure and commercial fertilizer is needed by the crops and a description of when and how nutrients and irrigation water (including wastewater) are applied. Although a NIWMP can be used in any farming operation, the following information specifically applies to dairies where manure and wastewater are applied to cropland.

Question: Why is a NIWMP prepared?

Answer: A NIWMP is used to ensure that crops receive an optimum amount of nutrients and water. If insufficient nutrients are applied, crop yields will be reduced. If excessive nutrients are applied, or if improper irrigation practices are utilized, adverse environmental impacts can result from nutrients entering surface or groundwater. In addition, over fertilization can reduce crop yields and is a waste of valuable resources (fertilizer purchases can be reduced and excess manure can be sold or used elsewhere).

Question: When should a NIWMP be prepared?

Answer: A NIWMP is required for confined animal feeding operations in the Central Valley Region of California if the facility has general waste discharge requirements issued by the Regional Water Quality Control Board (Board). A NIWMP may also be required by the Board as part of a Cleanup and Abatement Order or other enforcement action by or a county regulatory agency. However, a NIWMP is recommended for all confined animal feeding operations because it will help to optimize crop yields and protect the environment.

Question: Who prepares the NIWMP?

Answer: A NIWMP can be prepared by any person who understands crop nutrient and water requirements, has information on the properties of animal wastes, and has the essential site-specific information for the facility for which the NIWMP is being prepared. The site-specific information that is needed includes information on the waste management practices and the farming operations and generally must be obtained from the person(s) who manage the confined animal feeding operation and the cropland.

Question: What format is used for the NIWMP?

Answer: The Dairy Farm Advisors at the University of California Extension Service are developing a guidance document for preparation of a NIWMP. The guidance document should help anyone preparing a NIWMP by identifying essential information, providing generally accepted values, and presenting a logical format to follow. However, until the guidance document is available, there is no "standard" format to follow. Therefore, anyone required to prepare a NIWMP must develop their own format for a NIWMP. The following information is provided by staff in the Board's Sacramento office to assist dairy operators who must prepare a NIWMP before the Extension Service's guidance document becomes available.
Tables 1 and 2 can be used to estimate the amount of nitrogen available to crops from manure produced at a dairy. Table 1 is used to calculate the Animal Units (1,000 lbs each) at the dairy. Table 2 is used to estimate the nitrogen loading if the manure is applied to cropland. An alternate and superior way to evaluate the nitrogen loading is to have the holding pond contents and manure stockpiles analyzed periodically and to then use the reported nutrient values along with the wastewater and manure application rates to determine the nutrient-loading rate.

### TABLE 1: CALCULATION OF ANIMAL UNITS (AU)

<table>
<thead>
<tr>
<th>ANIMAL</th>
<th>A.</th>
<th>B.</th>
<th>C.</th>
<th>D.</th>
<th>E.</th>
<th>F.</th>
<th>TOTAL AU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor</td>
<td>Freestalls</td>
<td>Head</td>
<td>Head</td>
<td>Head</td>
<td>Head</td>
<td>Value From</td>
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<tr>
<td>Milk Cows</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B.7</td>
</tr>
<tr>
<td>Dry Cows</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D.7</td>
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<tr>
<td>Heifers (2 years and older)</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>F.7</td>
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<tr>
<td>Heifers (1 year to breeding)</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TOTAL</td>
</tr>
<tr>
<td>Calves (3 months to 1 year)</td>
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<td></td>
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<tr>
<td>Baby Calves (&lt; 3 months)</td>
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<td></td>
<td></td>
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<td>Subtotals</td>
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<td></td>
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</tr>
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</table>

Adjustments for Animal Breed: The AU values above are based on 1,000 pound AU per Title 40 Code of Federal Regulations, Section 122, and can be used directly for Jersey cows. For Guernseys, multiply the Milk Cow and AU values by 1.2 before using them in Table 2; for Holsteins, multiply the Milk Cow and AU values by 1.4 before using them in Table 2.

### TABLE 2: CALCULATION OF NITROGEN LOADING

<table>
<thead>
<tr>
<th>Value from Table 1&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Liquid Waste Factor</th>
<th>Liquid Waste Nitrogen</th>
<th>Solid Waste Factor</th>
<th>Solid Waste Nitrogen</th>
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<tbody>
<tr>
<td>B.7</td>
<td>x 0.8 x 0.45 x 0.25 x 365</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.1</td>
<td>x 0.8 x 0.11 x 0.25 x 365</td>
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</tr>
<tr>
<td>B.7</td>
<td>x 0.6 x 0.45 x 0.25 x 365</td>
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<td></td>
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</tr>
<tr>
<td>B.1</td>
<td>x 0.6 x 0.11 x 0.25 x 365</td>
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</tr>
<tr>
<td>D.7</td>
<td>x 0.6 x 0.45 x 0.25 x 365</td>
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<tr>
<td>D.1</td>
<td>x 0.6 x 0.11 x 0.25 x 365</td>
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<td>F.1</td>
<td>x 0.1 x 0.56 x 0.25 x 365</td>
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<td>F.1</td>
<td>x 0.9 x 0.56 x 0.25 x 365</td>
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</tr>
<tr>
<td>F.7-F.1</td>
<td>x 1.0 x 0.45 x 0.25 x 365</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal: Increase if wastewater is stored less than 30 days: x 2.0

TOTALS (pounds of N):

---

<sup>1</sup> Animal Units (AU) are calculated by multiplying the number of Head by the appropriate factor.

<sup>2</sup> The following assumptions used in calculating nitrogen values are consistent with assumptions used by staff in Muscat County: The animals are housed for 365 days/year; the nitrogen excretion rate is 0.36 lbs./Animal Unit/day for milk cows and 0.45 lbs./Animal Unit/day for other cows; 50% and 60% of the manure in freestalls and flushed corrals, respectively, is handled as a liquid. For milk cows in dry corrals or where alleys are scraped, 10% of the manure is in wastewater at the milk barn. When wastewater held less than 30 days is applied to cropland there is a 50% loss of nitrogen lost, and when wastewater held more than 60 days is applied to cropland, there is a 75% loss of nitrogen. There is a 75% loss of nitrogen from storage and application of dry manure. These values are based on various studies and reports; however, the values may be modified in the future as new information becomes available.

<sup>3</sup> For Guernseys and Holsteins, use adjusted values.
The following table can be used to identify the nitrogen needs of specific crops. The nitrogen requirement values are primarily taken from the Western Fertilizer Handbook (8th Edition, 1995) that also lists other crops and nutrients in addition to nitrogen. The county Farm Advisor may be able to provide requirements for specific crop varieties.

<table>
<thead>
<tr>
<th>CROP</th>
<th>YIELD ( tons )</th>
<th>LBS. N PER ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>8</td>
<td>480</td>
</tr>
<tr>
<td>Almonds</td>
<td>1.5</td>
<td>200</td>
</tr>
<tr>
<td>Barley</td>
<td>2.5</td>
<td>160</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>4</td>
<td>225</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>5</td>
<td>220</td>
</tr>
<tr>
<td>Clover-grass</td>
<td>6</td>
<td>300</td>
</tr>
<tr>
<td>Corn (grain)</td>
<td>5</td>
<td>240</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>30</td>
<td>250</td>
</tr>
<tr>
<td>Cotton (lint)</td>
<td>0.75</td>
<td>180</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>4</td>
<td>250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CROP</th>
<th>YIELD ( tons )</th>
<th>LBS. N PER ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>1.6</td>
<td>115</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>6</td>
<td>300</td>
</tr>
<tr>
<td>Prunes</td>
<td>15</td>
<td>90</td>
</tr>
<tr>
<td>Sunflower</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>Sorghum-sudan</td>
<td>8</td>
<td>325</td>
</tr>
<tr>
<td>Sugars Beets</td>
<td>30</td>
<td>255</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>30</td>
<td>180</td>
</tr>
<tr>
<td>Timothy</td>
<td>4</td>
<td>150</td>
</tr>
<tr>
<td>Vetch</td>
<td>7</td>
<td>390</td>
</tr>
<tr>
<td>Wheat</td>
<td>3</td>
<td>175</td>
</tr>
</tbody>
</table>

Using information obtained from Table 3 or other sources, the nitrogen requirements for cropland at a dairy can be calculated as shown in Table 4.

<table>
<thead>
<tr>
<th>Field Number or Name</th>
<th>Nitrogen Needs (lbs. N/acres)</th>
<th>Field Acres</th>
<th>Total lbs. N per Field (Field Acres x Total N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Crop</td>
<td>Second Crop</td>
<td>Third Crop</td>
</tr>
</tbody>
</table>

Evaluation of Nutrient Requirements: Using the total pounds of nitrogen available value from Table 2 and the total nitrogen requirement value from Table 4, an initial determination can be made as to the relationship between nitrogen availability and nitrogen need and whether or not it is necessary to export manure or to import fertilizer. As with any farming operation, periodic measurements of nitrogen in cropland and/or crops should be made in order to better determine nutrient requirements for optimum yield.

Developing the Nutrient and Irrigation Water Management Plan: A summary of the nitrogen availability and nitrogen need values and of the decision on exporting manure or importing fertilizer is the basis for the nutrient management plan. Although nitrogen is usually the nutrient of concern at confined animal facilities because of the potential for impacts to water quality, other nutrients should also be considered. Other information that may be included in the nutrient management plan includes a determination of the cropland characteristics and a description of when and how the manure and wastewater will be applied to cropland. The information on when can be presented in relation to crop planting and growth. The information on how can be related to the Water Pollution Prevention Plan, Stormwater Management Plan, or other document(s) related to waste and water management.

The relationship of cropland characteristics to irrigation water management should be considered when developing a NIWMP. The cropland characteristics that should be addressed in the NIWMP include the depth to groundwater, soil type(s), field dimensions and topography, irrigation method(s), drainage controls, and annual rainfall patterns.

Careful management of irrigation water is necessary to ensure that nutrients are applied to cropland at the desired rate and that adverse impacts to the environment are minimized. Proper irrigation results in even application of nutrients to cropland and prevents excessive percolation and runoff that can, respectively, result in adverse impacts to groundwater and surface water.

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*From Table 3 or equivalent source. May be adjusted for crop yield.*
The Irrigation Water Management component of a NTWMP is a written description of procedures that are followed for proper irrigation, and should address the following topics:

- Procedures that are used to mix wastewater and "clean" irrigation water
- The irrigation system used to apply wastewater to cropland
- The methods used to determine and control the rate of application
- Procedures followed to determine when sufficient water has been applied
- Physical and management controls used to prevent tailwater containing manure from moving off of the dairy
- Controls that will be used if it becomes necessary to apply wastewater to land during the rainy season
- Procedures used to prevent irrigation with wastewater from creating nuisance conditions.

In addition, the NTWMP should contain figures that show the location of cropland where manure and wastewater is applied. The figures should show nearby water courses and ditches, the slope of irrigated lands, the location of wells and pumps, and points from which tailwater can be discharged. If wastewater is applied to property under different ownership than the dairy, a copy of agreements on the application of wastewater to the property should be included.

Additional information related to the preparation of Nutrient and Irrigation Water Management Plans is available in the "Environmental Stewardship Short Course for California Dairy Operators" presented by the University of California Cooperative Extension in cooperation with the California Farm Bureau, Milk Producers Council, and Western United Dairymen. For more information about the water quality programs that apply to confined animal facilities, contact the RWQCB dairy regulatory staff at one of the following offices:

- Sacramento (916) 255-3000
- Fresno (559) 445-5116
- Redding (916) 224-4845
Introduction

The California Water Code requires that animal wastes be managed to protect water quality. To help achieve protection, regulations established pursuant to the Water Code (reference California Code of Regulations, Title 27, Subdivision 1, Chapter 7, Subchapter 2, Article 1, Section 22362d) require that holding ponds utilized for animal wastes be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or be lined with artificial materials of equivalent impermeability. In addition, the Tulare Basin Water Quality Control Plan and some county ordinances require a 5-foot separation between the bottom of a holding pond and the highest anticipated groundwater elevation.

Title 27 also requires that manured areas (including corrals) be managed to minimize infiltration of water into underlying soils. Consequently, corrals and manure storage areas are usually designed and managed to reduce the potential for standing water ("ponding"). There are no state regulations that specify soil characteristics for corrals or manure storage areas. However, soils with low levels of clay and without underlying restrictive layers (such as a hardpan) are likely to allow significant infiltration. Studies conducted at dairies by the Central Valley Regional Water Quality Control Board have identified impacts to groundwater from corrals and manure storage areas.

The following information is provided to assist dairy owners who want to obtain soil and groundwater information related to environmental issues at existing or proposed dairy sites. Obtaining site-specific information is useful in developing recommendations for dairy design and operation. The following are not requirements, but can serve as a guide for discussions with consultants who conduct environmental assessments.

Assessments of Holding Pond Sites

Clay and gravel content in the sides and bottom of holding ponds is best evaluated by collecting samples from the pond excavation. However, an initial evaluation of soils can be made by using soil borings before the start of pond construction. The borings can also provide information on expected depth to groundwater. Cuttings or cores from the borings can be examined in the field by a geologist or soil scientist to assess soil type and soil variability at the site. If desired, soil samples from borings can be submitted for laboratory analysis to evaluate clay content and/or nitrogen levels. Borings can be also be used to evaluate several potential pond locations and the site with the "best soils" for a pond can be identified.

Assessments of Corrals

Soil borings in existing or proposed corrals can provide information on soil conditions including the presence of conditions that will restrict percolation. Analysis of soil samples from the borings can provide information on nitrogen levels under the corrals. Subsequent soil sampling and analysis can identify any changes in nitrogen levels to help assess the potential for corrals to impact groundwater.
Soil Borings

Soil borings can be completed with a drill rig or with direct-push technology. An alternative is to use a backhoe to construct trenches that can be used to examine site conditions and to collect soil samples. A qualified consultant can recommend the choice of technology based on expected site conditions and on cost and time considerations. The consultant can also recommend the placement and number of soil borings.

If a drill rig is used, continuous coring is recommended to allow an accurate assessment of soil conditions; an alternate but inferior method is to have a geologist log cuttings to evaluate the soil profile. When using a drill rig, soil samples can be collected at selected intervals by using a drive sampler. If direct-push technology is used, a cross section of the soil column is obtained inside plastic tubes that can then be sectioned to obtain soil samples to send for analysis.

Evaluation of Soil Samples

Soils from borings or excavations can be visually and tactually assessed in the field by a qualified geologist or soil scientist (reference ASTM Standard D2488 "Practice for Description and Identification of Soils - Visual-Manual Procedure"). Samples can be analyzed in a laboratory to evaluate clay and gravel content (reference ASTM Standard D422 "Particle Analysis of Soils"). Samples to be evaluated for nitrogen should be analyzed for nitrate ($NO_3^-$) and for total Kjeldahl Nitrogen (TKN) by a state-certified laboratory using approved methods. There are also a number of soils tests that can be run to assess engineering properties of soils that may be useful in evaluating suitability of sites for buildings or other facilities.

Evaluation of Groundwater

Initial information on expected groundwater conditions can often be obtained from regional sources such as state or county agencies or irrigation districts. Local information may be available from wells constructed at nearby properties. Leaving a backhoe excavation open overnight may indicate if the groundwater elevation is higher that the base of the excavation. However, obtaining site-specific groundwater information generally requires the installation of monitoring wells. In some cases, temporary monitoring wells can be installed using direct-push technology, but such wells may not be allowed in some counties and will generally not be adequate for long-term monitoring. Permanent monitoring wells are usually installed with a drill rig and must meet county construction and administrative requirements. A minimum of three wells is generally required in order to assess groundwater gradients and evaluate upgradient ("background") water quality. Well head elevations need to be surveyed to a common reference point (usually mean sea level) and the depth to water needs to be periodically recorded (usually at the time of sampling) to establish groundwater gradients. Water samples should initially be analyzed for standard minerals, total dissolved solids (TDS), and nitrogen-containing compounds to obtain information that can be evaluated to assess impacts to water quality. An ongoing groundwater monitoring program may be focused at parameters of most concern (for example, TDS and $NO_3^-$) for periodic sampling and involve only an occasional wider range of tests.

Presentation of Results

A report should be prepared describing the field investigations and presenting the reported analytical results for samples submitted for analysis. Figures should be used to identify the locations of soil borings and sample collection. Photographs may be used to supplement the figures. Soil profiles should be presented graphically using boring logs. Groundwater gradient information should be presented in figures and tables and regional and local groundwater information should be summarized in a narrative format. Reported analytical results should be summarized in tables and graphs and the laboratory reports should be included as an appendix. A grain size distribution chart is useful for presenting results of clay and gravel content assessments of soil samples.
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
Fact Sheet No. 6 For Dairies

Introduction

The California Code of Regulations (Title 27, Subdivision 1, Chapter 7, Subchapter 2, Article 1, Section 22562d) requires that holding ponds utilized for animal wastes be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or be lined with artificial materials of equivalent impermeability. In addition, the Tulare Basin Water Quality Control Plan and some county ordinances require a 5-foot separation between the bottom of a holding pond and the highest anticipated groundwater elevation. The following information is provided to assist dairy owners who want to construct a dairy waste holding pond and need to document that the pond meets the legal requirements.

Initial Assessments of Soils at Proposed Holding Pond Sites

An initial evaluation of soils at proposed holding pond locations can be made by using soil borings before the start of pond construction (see Fact Sheet No. 5 for Dairies). The borings can also provide information on expected depth to groundwater. Cuttings or cores from the borings can be examined by a geologist or soil scientist to assess soil type. If desired, soil samples from borings can be submitted for laboratory analysis to evaluate clay and gravel content.

For some proposed pond locations, observations or available information (such as a county soil survey) may indicate that soil will not meet the required clay and gravel limits. In such instances, no samples of native soil are collected, and the pond is constructed with a liner of imported soil that meets the required clay content. Samples of the completed liner should be collected and analyzed as described below to document that the required values are met.

Visual and Tactile Assessments of Soils in Pond Excavations

In most instances, clay and gravel content in the sides and bottom of holding ponds is evaluated by collecting samples from the pond excavation. The number and location of samples depends on site specific conditions as determined by visual and tactile assessment. The visual assessment documents soil appearance that indicates different soil types are present in the excavation. Tactile assessment refers to an evaluation of the soil "feel" when it is dry and wet. Such assessments when conducted by a trained or experienced person (i.e., a "qualified person") can indicate the presence of significant amounts of sand and clay. The results of the visual and tactile assessments should be documented as discussed below.

It is normal to find horizontal layers of soil with different properties. In most instances, the different layers have different appearances (color or structure) and/or a different "feel". A written description of the visual assessment and tactile assessment (i.e., feel of soil in the different layers) should be prepared. The written description should be supplemented by drawings as appropriate (see attached example). The drawing can be done by hand or computer. Photographs may also be used to document the visual assessment. Each significant layer should be assessed, and the description should focus on observations related to clay and gravel content. At least one composite sample of soil from each significant layer should be collected and analyzed as described below.
Collection of Soil Samples

Representative samples of soil in pond excavations should be collected and submitted for analysis of clay and gravel content. As previously noted, the number of samples will depend on the observed conditions in the pond excavation. If the pond excavation has homogenous soils in the sidewalls and bottom (an unusual condition), only one composite sample may be adequate if the clay content is significantly greater than 10%. More often, several individual or composite samples are submitted in order to document uniformity and to assess each soil layer that appears to be different. Each composite sample may be composed of soil collected from several (3 to 10) locations within the excavation as long as the soil in each location appears to be essentially the same. Diagrams should be used to show the locations of the samples that were used to create each composite (see attached example). If the clay content is expected to be relatively low, more individual samples should be collected to assess spatial variability and minimum clay content in different locations.

When imported soil is used to create a pond liner, a composite sample of the constructed liner should be collected and analyzed. Any damage done to the liner as a result of sample collection should be repaired. If the liner does not cover the entire excavation (i.e., bottom and sidewalls), one or more composite samples of the exposed native material should also be collected. Again, diagrams should be used to show the locations of the samples that were used to create each composite.

Analysis of Soil Samples

The soil samples collected from the pond excavation should be submitted to a commercial laboratory for soil particle size analysis. When using a laboratory for the first time, it is desirable to review their qualifications and quality assurance / quality control (QA/QC) procedures. Although the focus is on clay and gravel content, the laboratory should be requested to also report the percentages of silt and sand in the sample; there will be little or no additional cost for such reporting. Most laboratories will also provide QA/QC information at no additional cost when reporting analytical results.

Groundwater Assessments

In locations where the county or regional board requires a 5-foot separation between the base of a holding pond and highest anticipated groundwater, documentation should be provided showing that the proposed pond location meets the criteria. Information on the depth to groundwater and historical fluctuations in groundwater elevations may be obtained from soil borings, wells, and/or from historical information provided by county or local agencies.

Presentation of Results

A report should be prepared presenting a summary of the visual and tactile soil assessments, a description of the soil sampling and compositing procedures, the reported analytical results, and relevant information on groundwater. Figures should be used to describe the observed soil conditions in the excavation and to identify the sample collection sites. Photographs may be used to supplement the figures. Reported analytical results should be summarized in tables and the laboratory reports should be included as an appendix. Groundwater information should be summarized relative to the pond construction. Relevant groundwater data should be included as an appendix.

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1 A composite soil sample is obtained by thoroughly mixing equal quantities (by weight or volume) of soil from two or more locations. For example, five 1-pound samples may be mixed in a 5-gallon pail, and a single 1-pound composite sample removed and sent for analysis. For holding pond site evaluations, composite samples are used only when the soil in each location appears to be essentially the same based on visual and tactile assessment. Composite samples should not be created from soil samples that have different appearances or feel.
EXAMPLE: HOLDING POND SITE ASSESSMENT
Nosuch Dairy
1234 Road Y, Pleasant, California

The pond location is shown on the attached map. The pond excavation was completed on 15 August 1998. As shown on the attached sketch, the pond excavation is approximately 200 feet by 500 feet by 17 feet deep. Some of the excavated soil was used to create a raised berm that is 5-feet high and 10-feet wide so that the finished pond with a 2 foot thick clay liner is approximately 20 feet deep. The remaining excavated soil was used in corrals.

An initial assessment of soil in the excavation indicated that there are five soil layers as shown on the attached sketch. The soil texture classifications are based on a visual and tactile assessment conducted by Mr. William Jones. Mr. Jones’ business address, phone number, and qualifications for conducting soil assessments are attached. The five identified soil layers are:

1. A brown sandy loam to approximately 3 feet below grade
2. A dark brown sandy clay loam approximately 2 feet thick
3. A reddish-brown sandy loam approximately 4 feet thick
4. A hardpan (claypan) approximately 1 to 2 feet thick (see attached photograph)
5. Light brown loamy sand to the base of the excavation

Based on the visual inspection of the soil, it was determined that a 2-foot thick liner consisting of imported clay soil would be placed in the bottom of the excavation and would extend approximately 6 feet up the sidewalls. The imported soil was obtained from McNoughts Soil Products in Lone, California. The liner was completed on September 2, 1998.

Three 1-pound composite soil samples from the excavation and liner were submitted to Z&Z Laboratories in Mercer, California. The composites were made from 1-pound individual samples collected by excavating an area approximately 4” by 4” by 6” deep. The individual samples were composted by thoroughly mixing the individual samples in a plastic bucket and then removing a sample. The composite samples are described below:

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Composite of eight 1-pound soil samples of the first sandy loam layer (two from each sidewall and endwall) collected approximately 3 to 5 feet below ground surface (bgs)</td>
</tr>
<tr>
<td>S2</td>
<td>Composite of eight 1-pound soil samples of the second sandy loam layer (two from each sidewall and endwall) collected approximately 8 to 11 feet bgs</td>
</tr>
<tr>
<td>L1</td>
<td>Composite of four 1-pound soil samples of the liner after placement (see sketch).</td>
</tr>
</tbody>
</table>

No samples of the sandy clay loam layer were collected because the layer had significantly more clay than the sandy loam layers that were above and below it. No samples of the hardpan or the loamy sand layer were collected because they were covered with the imported clay soil. The analytical results for the submitted samples are summarized below. The laboratory reports are attached. Available groundwater information (copy attached) indicates that the highest recorded local groundwater is approximately 10 feet below the base of the pond excavation.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>% Sand</th>
<th>% Silt</th>
<th>% Clay</th>
<th>Soil Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>63</td>
<td>24</td>
<td>13</td>
<td>Sandy Loam</td>
</tr>
<tr>
<td>S2</td>
<td>53</td>
<td>35</td>
<td>12</td>
<td>Sandy Loam</td>
</tr>
<tr>
<td>L1</td>
<td>22</td>
<td>28</td>
<td>50</td>
<td>Clay</td>
</tr>
</tbody>
</table>
Introduction

The State of California has laws and regulations that apply to the design and construction of holding ponds used for storage of animal wastes. The Professional Engineers Act (Business and Professions Code Sections 6700-6799) and the California Code of Regulations (CCR) Title 16, Sections 400-474.5 identify activities that are considered civil engineering including "studies or activities in connection with fixed works for irrigation (and) drainage." The Board of Registration for Professional Engineers and Land Surveyors considers the design of holding ponds for animal wastes to be civil engineering.

In addition, the General Construction Criteria for Class II Waste Management units in CCR Title 27, Division 2, Section 20310(e) states that "Containment structures shall be designed by, and construction shall be supervised and certified by, a registered civil engineer or certified engineering geologist (CEG)." Staff from the State Board of Registration for Geologists and Geophysicists has stated that a CEG can design holding ponds for animal waste.

It is unlawful for anyone to practice or offer to practice civil engineering unless currently registered by the Board of Registration. However, an unregistered or unlicensed person is allowed to perform civil engineering services if the person is:

- a federal officer or employee, or
- under the responsible charge and direct supervision of a registered professional engineer.

Additional regulations that apply to design requirements for holding ponds utilized for animal wastes are contained in CCR Title 27, Subdivision 1, Chapter 7, Subchapter 2, Article 1, Section 22562. These regulations require that such ponds be protected from stream-channel overflows during 100-year peak flows. They also require ponds to be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or be lined with artificial materials of equivalent impermeability. Information on evaluating the clay content of holding ponds is presented in the Central Valley Regional Water Quality Control Board's ("Regional Board's") Fact Sheet No. 6 For Dairies "Evaluating Proposed Waste Holding Pond Sites." When lining is necessary, the Regional Board requires that a registered civil engineer design the liner and certify that it complies with the state regulations.

Design of Animal Waste Holding Ponds

The design of animal waste holding ponds is largely dependent on site-specific conditions including the depth to groundwater and the soil type. As discussed in Regional Board Fact Sheet No. 5 "Soil And Groundwater Assessments For Dairies," an initial assessment of site conditions may be performed before the pond design is finalized and construction is started. If the pond will include a liner, the liner type may influence the shape and depth of the pond excavation. If a lined pond will be mechanically cleaned, the pond design should consider the need to protect the liner. The pond design should also meet local requirements such as mosquito abatement district requirements for access and planning department requirements for setbacks from wells, housing, and property lines. There may also be applicable regulations that specify the minimum separation between the base of the pond and highest anticipated groundwater.
Construction of Animal Waste Holding Ponds

The actual construction of an animal waste holding pond may be done by a contractor that is not a registered civil engineer. However, the contractor cannot perform the duties of a civil engineer including:

- the selection and comparison of engineering alternatives;
- the selection or development of design standards or methods, and materials to be used;
- the selection or development of techniques or methods of testing to be used in the evaluation of construction methods or controls;
- the evaluation of test results, materials, and workmanship affecting the integrity of the completed work; or
- the development and control of operating and maintenance procedures.

Documentation of Pond Construction and Operation

The facility owner should retain records documenting that animal waste holding ponds are adequately constructed and maintained. Such documentation includes:

- any report describing assessments of soil and groundwater conditions in the vicinity of the pond prior to the start of pond construction;
- a report summarizing the sampling procedures and the reported analytical results for soil samples collected from the pond excavation and from any clay liner used in the pond;
- engineering specifications for the pond and, if applicable, the pond liner and an engineers description of any maintenance activities necessary to maintain the pond integrity;
- documentation that the pond was constructed according to the design specifications. Such documentation may include photographs, inspection logs, test results documenting proper construction of any liner, and an engineer's statement describing the completed pond;
- documentation that the pond has been maintained according to the design specifications. Such documentation may include inspection logs and records of pond cleaning and maintenance activities.

Contacts for Further Information

For more information about the water quality programs that apply to confined animal facilities in the Central Valley, contact Regional Board dairy regulatory staff at the following offices:

- Sacramento (916) 255-3000
- Fresno (559) 445-5116
- Redding (916) 224-4845
Introduction:

To meet requirements of Section 303(c) of the Federal Clean Water Act and Section 13240 of the California Water Code, the Central Valley Regional Water Quality Control Board reviews the water quality standards contained in the Water Quality Control Plan for the Tulare Lake Basin (Basin Plan) every three years. This Triennial Review (TR) consists of conducting a public workshop to receive comments on water quality problems in the Basin and preparing a work plan which describes the actions the Board may take over the next three years to investigate and respond to the problems. Implementation of the work plan depends upon the Board’s program priorities, resources, and other mandates and commitments. Crucial to successful implementation of the actions is adequate support of the Board’s Basin Plan activities.

The Board began its 1998 Triennial Review for the Tulare Lake Basin Plan by providing a 45-day public notice, culminating in a public workshop, to solicit comments on water quality problems. The public notice (Attachment A) contained a brief description of some problems identified by staff. The notice was mailed to the 684 entities on the Basin Plan mailing list and published for one day in each of the four major newspapers covering the Tulare Lake Basin area (Attachments B and C).

The public workshop was held during the regularly scheduled Board meeting on 23 October 1998 to receive oral comments. Attachments D and E are copies of the official agenda and minutes, respectively, of the 422nd meeting of the Board at which the TR public workshop was held. Comments submitted after the public workshop were also considered in this review. The Board received a total of ten comments (Attachment F). Responses to these comments are contained in Attachment G.

The issues listed below reflect the water quality problems identified from public comments received during the review period and staff knowledge about problems in the Basin. The Board does not propose to proceed directly with amendments to the Basin Plan as a result of this TR. The proposed actions consist of recommended investigations to determine the following:

1. Whether a problem exists at all.
2. The extent, source, frequency, duration, and magnitude of the problem.
3. Whether the problem can be resolved through a change in the way the Board implements, enforces or otherwise gains compliance with existing standards.
4. Whether the problem must be resolved through amending the Basin Plan.

Two levels of actions are specified. Primary Actions represent the staff’s best judgment about what can be done from FY 98/99 through FY 99/00 to address the issue with available resources. Augmented
Actions depend on more resources becoming available. The priority for each issue indicates the order staff intends to address the issues.

Resources to support basin planning activities are very limited. The Regional Water Board annual budget to support basin planning activities is 1.5 PYs. From this resource, the Regional Water Board must conduct triennial basin plan reviews and prepare and propose amendments to the two Basin Plans that cover the Region. The FY 98-99 allocation will be exhausted conducting the two triennial reviews. A new triennial review will need to be completed three years from now. This leaves 1.5 PYs for 2 years (the two years between Triennial Reviews) to consider issues that may warrant revisions to the two Basin Plans. Therefore, with existing resources, only a small portion of the high priority issues can be addressed. For some high priority issues, resources from other sources have been and can be used for some of the pre-basin planning activities. For example, resources from the Bay Protection and Toxic Cleanup Program were used to monitor and develop cleanup plans for mercury and dissolved oxygen. These cleanup plans will form the basis for a Total Maximum Daily Load Allocation (TMDL). Portions of the TMDL need to be incorporated into the Basin Plan. The Basin Plan amendment activities associated with incorporating the TMDL into the Basin Plan are not eligible for funding from most other funding sources.

The Regional Water Board has resources from other sources that can complement Basin Planning activities. For example, the Regional Water Board receives resources from US EPA to work on nonpoint source implementation programs. Funding from this program cannot support Basin Plan amendment activities, but it can support implementation of provisions already in or added to the Basin Plan. Likewise, funding from US EPA supports a limited amount of TMDL development activity, but the inclusion of TMDL elements into the Basin Plan must be supported from the limited Basin Planning allocation. A special budget allocation has supported development of TMDLs for selenium in the San Joaquin River Basin. Only the activities directly related to incorporating elements of the TMDLs into the Basin Plan should be considered for funding from the limited Basin Planning allocation. The highest priority for use of the limited amount of Basin Planning resource should be to complete or initiate high priority work that cannot be funded from other sources. With existing resources, only a few of the highest priority issues can be addressed.

Based on the staff analysis, the following issues have been identified as high priority.

- Groundwater Assessment - Issue No. 1
- Groundwater Quality Objectives for Salinity - Issue No. 2
- Electrical Conductivity Effluent Limit - Issue No. 3
- Salinity in the Lower Kings River - Issue No. 4
- Nitrates - Issue No. 12

The Regional Water Board is identified as the funding source for a Primary Action if the issue is already funded in the FY 98/99 budget. The State Water Board is identified as the funding source for Primary
Actions not yet in the Regional Water Board budget, i.e., those beyond FY 98/99. The State Water Board is also the most likely funding source for Augmented Actions.

The issues selected for the 1998 TR represent major water quality concerns derived from what is currently known about them. Knowledge about pollution problems may change significantly from one year to the next.

**Issue No. 1:**

**Groundwater Assessment**

The Tulare Lake Basin is essentially a closed basin because surface water only drains north into the San Joaquin River Basin in years of extreme rainfall and because there is little subsurface outflow. Degradation of ground water in the Tulare Lake Basin by salts is unavoidable without a plan for removing salts from the Basin. The Regional Water Board considers a valleywide drain to be the best technical solution but it does not appear to be imminent. The only other solution is to manage the rate of degradation by minimizing the salt loads to the groundwater body. The Regional Water Board’s programs to manage salt increases are contained in the Basin Plan and focus on reducing incremental salt increases in municipal and industrial wastewaters. An assessment of the groundwater condition is needed to determine how effective the Board’s programs have been in protecting the groundwater. The Basin Plan describes a groundwater monitoring network for the Tulare Lake Basin that was never established. The monitoring network would be used to track trends in water quality and data from the network is needed to review the groundwater quality objectives for salinity and effluent EC limits.

Many of the water agencies within the Tulare Lake Basin have groundwater management plans which include monitoring programs. Staff should work with the water agencies to share information in protecting water quality and implement a modified network that might meet Board needs. Water agencies and staff should identify areas within the Tulare Lake Basin where the groundwater is adversely impacted by salts and chemicals to the extent that the groundwater no longer supports all its beneficial uses. Where presence of salts and chemicals are due to nonpoint source impacts and the source is not clear, investigations should be done to identify potential sources of these contaminants and practices should be developed to mitigate these impacts. Where areas of the Basin are threatened with increasing salinity, practices should be developed to reduce these impacts.
Priority: High

Primary Action: Focus efforts on a key subbasin. Solicit assistance from local water agencies within the Kings Groundwater Subbasin by meeting with the agencies and stakeholders and explaining the purpose and need for a groundwater monitoring network. Form an advisory group for this groundwater subbasin. Decide on methodology to identify trends within the subbasin. Decide on list of desired constituents of interest. Implement methodology.

Implementation Requirements for proposed Primary Action: 1) Staff — 0.6 PY for FY98-99, 0.8 PY for FY99-00, 0.8 PY for FY00-01

2) Contract(s) — $10,000 per year

3) Source(s) — Regional Water Board and State Water Board

Augmented Action: The primary action will be expanded to include additional subbasins.

Implementation Requirements for proposed Augmented Action: 1) Staff — 3.0 PY per year

2) Contract(s) — $50,000 per year

3) Source(s) — State Water Board

Issue No. 2: Groundwater Quality Objectives for Salinity

Discussion: The Basin Plan contains water quality objectives for control of salinity increases in groundwater. These objectives allow for what was believed to be reasonable increases in certain areas of the basin based on land use in these areas. These objectives have never been revisited for effectiveness or practicality. A study should be conducted on the appropriateness of the objectives.

Primary Action: Evaluation of the objectives must be deferred until a groundwater monitoring network is completed. In the meantime, the groundwater information and estimates used as a basis for the First Edition of the
Basin Plan will be revisited to make an updated prediction of what data from the groundwater monitoring network might show.

Priority: High

Implementation Requirements for proposed Primary Action:

1) Staff – 0.2 PY for FY98-99, 0.3 PY for FY99-00, 0.3 PY for FY00-01

2) Contract(s) -- $0

3) Source(s) -- Regional Water Board and State Water Board

Issue No. 3: Electrical Conductivity Effluent Limit

Discussion:

The Basin Plan contains electrical conductivity effluent limits for discharges of municipal and domestic, industrial, and oil field wastewaters. Municipal and domestic discharges are limited to the electrical conductivity (EC) of the source water plus 500 micromhos/cm.

Industrial dischargers are required to meet a limit of 500 micromhos/cm unless it can be demonstrated that allowing a greater net incremental increase in EC will result in lower mass emissions of salt and in conservation of water. Industrial dischargers are also allowed an exception if the increased electrical conductivity is due to an unavoidable concentration of organic dissolved solids from the raw food product. In both these exceptions, beneficial uses must still be protected.

Oil field dischargers are required to meet a limit of 1000 micromhos/cm unless the discharger can successfully demonstrate to the Regional Water Board in a public hearing that the proposed discharge will not substantially affect water quality nor cause a violation of water quality standards.

The Regional Water Board has been requested by municipal dischargers to revise the EC effluent limit in order to take into consideration water conservation measures. Suggestions from commenters were to regulate agricultural dischargers, develop an electrical conductivity credit for calcium, potassium, and magnesium, establish a discharge limit for total...
pounds of salt in lieu of EC discharge requirement, and apply the 500 μmhos/cm increase to receiving rather than source water.

Priority: High

Primary Action: The characteristics of the municipal wastewaters will be studied to determine typical mineral composition, sources of atypical salt concentrations and alternative salinity control measures. The reuse of certain salts as agricultural amendment will be evaluated as a potential credit. In addition, water conservation measures will be studied to determine the overall effect on electrical conductivity increase.

Implementation Requirements for proposed Primary Action:

1) Staff – 0.1 PY for FY98-99, 0.2 PY for FY99-00, 0.3 PY for FY00-01

2) Contract(s) – $5,000 per year

3) Source(s) – Regional Water Board and State Water Board

Issue No. 4: Salinity in the Lower Kings River

Discussion: The Lower Kings River cannot meet water quality objectives for salinity during drought periods. Additional studies are needed to adequately define the salinity problems and develop policies.

Priority: High

Primary Action: If drought conditions occur during this triennial review period, conduct studies to determine source of salinity problems, identify salinity impacts both locally and regionally, and develop potential mitigation measures.

Implementation Requirements for proposed Primary Action:

1) Staff – 0.3 PY for FY98-99, 0.3 PY for FY99-00

2) Contract(s) – $5,000 per year

3) Source(s) – Regional Water Board and State Water Board
Issue No. 5: Dissolved Oxygen Objectives

Discussion:
The dissolved oxygen objective for Reach III of the Kings River (Pine Flat Dam to Friant-Kern) may not be achievable due to natural conditions. A study should be conducted to investigate this and establish more appropriate objectives, if necessary. Commenters have suggested that the dissolved oxygen objective for Reach III of the Kings River should be a revised from a minimum of 9.0 mg/l to 7.0 mg/l.

Priority: Medium

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action:
The Kings River Conservation District has supplied the dissolved oxygen monitoring for the powerhouse and for selected points within the affected reach. This information should be analyzed to determine the dissolved oxygen concentration which this reach can reasonably attain.

Implementation Requirements for proposed Augmented Action: 1) Staff – 0.25 PY
2) Contract(s) – $0
3) Source(s) -- State Water Board

Issue No. 6: Individual Disposal Systems

Discussion:
Many areas within the Tulare Lake Basin are not suitable for conventional septic tank/leachline systems according to the Guidelines for Waste Disposal from Land Developments. In these areas, the Basin Plan specifies a community system or a specially designed system. Other than requiring the submittal from a registered engineer, geologist, or sanitarian who is knowledgeable and experienced in the field of septic tank-leaching system design and installation, there are no guidelines. In 1994, the State Water Board assembled a Technical Advisory Committee (TAC) to consider the major water quality
problems resulting from onsite sewage disposal systems (OSDS) and the effectiveness and the efficiency of implementing the U. S. Environmental Protection Agency’s management measures. The TAC identified several issues of concern including degradation of water quality resulting from the use of OSDS, inconsistent statewide standards for OSDS, inconsistent statewide regulatory approach for OSDS, and limited knowledge and acceptance of alternative technologies for OSDS. The TAC recommended adoption of local and regional policies and procedures for OSDS to protect beneficial water uses and development of numerical and narrative water quality objectives into statewide plans and policies to ensure compliance.

Areas in the Central Valley which may require modified guidelines are higher elevation areas with shallow soils and valley floor areas with high groundwater.

As the population of the state increases, more people are moving into subdivisions in foothill and higher elevation areas. Some of the foothill and higher elevation areas have slopes greater than 30% with less than one foot of soil cover. In these areas, county requirements vary with some counties allowing engineered alternatives and others prohibiting septic tank systems altogether. In most cases, county requirements do not reflect the potential cumulative impacts of dense installation of onsite sewage disposal systems in these areas.

On the valley floor, a problem may develop in some agricultural areas of the Basin owing to saturation of the soil when irrigation water along the valley trough is restricted from percolating through the soil profile. As the areal extent of this condition expands, individual waste disposal systems in areas where community sewers are not an option may create surfacing waste and a public health problem.

The Regional Water Board should investigate both these potential problems and provide updated regional guidelines to assist county review of engineered systems.

Priority: Medium
Primary Action: None
Augmented Action: Gather information on conventional and engineered alternative individual waste disposal systems. Form advisory committee with
County Health Departments. Identify criteria for areas where conventional systems are likely to fail. Propose suitable guidelines for these areas.

Implementation Requirements for proposed Augmented Action: 1) Staff – 1.5 PY

2) Contract(s) – $0

3) Source(s) – State Water Board

Issue No. 7: 
Riparian Corridor Protection Policy

Discussion: The Basin Plan does not include any sections on current regulatory activities in riparian corridors or recognize the importance of these areas to naturally filter runoff and provide habitat.

Priority: Low

Priority: Medium

Primary Action: None

Augmented Action: Provide a description of current regulatory activities in riparian corridors. Identify the benefits of these corridors. State the Regional Board’s policies and recommendations for these areas.

Implementation Requirements for proposed Augmented Action: 1) Staff -- 0.2 PY

2) Contract(s) – $0

3) Source(s) – Regional Water Board and State Water Board

Issue No. 8: 
Tributary Language

Discussion: Clarification is needed from the tributary language which reads, “The beneficial uses of any specifically identified water body generally apply to its tributary streams. In some cases a beneficial use may not
be applicable to the entire body of water. In these cases the Regional Water Board’s judgment will be applied.

Priority: Low

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action: Review the tributary language to identify ambiguities and revise accordingly.

Implementation Requirements for proposed Augmented Action: 1) Staff – 1.0 PY

2) Contract(s) – $0

3) Source(s) – State Water Board

Issue No. 9: TMDLs

Discussion: The Tulare Lake Basin has three waterbodies on the 303(d) list. The San Carlos Creek was listed for mercury, the Panoche Creek was listed for sediments, selenium and mercury, and the Lower Kings River was listed for molybdenum, toxaphene and electrical conductivity. All TMDLs are scheduled to start January 2004. However, if funding were available, the Board could consider plans for early development and implementation of TMDLs for the listed waterbodies in the Tulare Lake Basin.

Priority: Medium

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action: Conduct monitoring for listed constituents, develop and calibrate water quality models characterizing the system, calculate the total constituent loads the streams may handle, allocate loads to the sources.
Implementation Requirements for proposed Augmented Action: 1) Staff — 6.0 PY

2) Contract(s) — $20,000

3) Source(s) — State Water Board

Issue No. 10: Confined Animal Facilities

Discussion:
Exempt confined animal facilities from the requirement that new manure retention ponds be designed, constructed, and operated to ensure that the invert of the pond will be at least 5 feet above the highest elevation of underlying groundwater for facilities where it is shown that (1) the quality of underlying groundwater is poorer, for each constituent of concern, than that of the wastewater, and (2) that the discharge does not cause the poor quality ground [water] to adversely impact downgradient groundwater quality.

Priority: Low

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action: Modify basin plan.

Implementation Requirements for proposed Augmented Action: 1) Staff — 0.25 PY

2) Contract(s) — $0

3) Source(s) — State Water Board

Issue No. 11: Salt Loads

Discussion: In order to properly develop management measures for potential salinity sources, an understanding is needed of the salt storage which is occurring in the basin. The Department of Water Resources has
completed calculations of the salts which are imported and exported through the water projects but has not included salts which are imported and exported through food sources (both for human and animal consumption) and soil amendments.

Priority: Low

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action: Work with the county farm advisors, city and county planners, and the Department of Water Resources to quantify the salts which are imported as food and soil amendments and the salts exported as products from the basin. Calculate the salts which are stored in the basin. Develop strategies to reduce the salt imports or export the excess salt.

Implementation Requirements for proposed Augmented Action: 1) Staff -- 1.0 PY

2) Contract(s) -- $0

3) Source(s) -- State Water Board

Issue No. 12: Nitrates

Discussion: A 1988 State Water Resources Control Board report to the State Legislature on Nitrate in Drinking Water (SWRCB, 1988) reported that 10 percent of the samples in the Storet database were above the primary Maximum Contaminant Level (MCL) (10 mg/L nitrate-nitrogen). A geographical depiction of wells with elevated levels of nitrate (greater than 4.5 mg/L nitrate-nitrogen) showed the highest densities in the Central Valley are along the Highway 99 corridor and primarily around populations centers (e.g. Modesto, Yuba City, Fresno, and Bakersfield). Since 1980, over 200 municipal water supply wells have been closed in the Central Valley due to exceedance of the nitrate MCL (RWQCB, 1996).
The actual nitrate groundwater contamination situation may be much greater than realized by the SWRCB geographical depiction and statistics of closed wells. The groundwater nitrate database is biased with respect to large water systems. Domestic wells with less than 15 connections are not subject to state oversight and those with less than 5 connections are not subject to any monitoring requirements. These small systems are the most vulnerable to contamination by nitrate. The wells are generally placed as shallow as possible due to limited resources of small and private systems and because only limited yields are required. Large water supply systems, on the other hand, with greater economic resources, generally tap deeper aquifers where there is more reliable water supply and quality. Additionally, small systems are more likely located in agricultural areas and be affected by agricultural activities such as crop and confined animal production. Septic systems, also located in rural areas, are also a principal source of groundwater contamination with nitrate. Additionally, as nitrate moves into the deeper aquifers, more water systems will become affected. Recent monitoring by the US Geological Survey of 60 household wells located in agricultural areas found 30 percent of the wells exceeded the drinking water standard.

The primary health concerns with the consumption of water with elevated nitrate is the condition known as methemoglobinemia. Methemoglobinemia, commonly known as the blue baby syndrome, is the interference by nitrate to the absorption of oxygen by hemoglobin. Infants, younger than 6 months, are most susceptible and the oxygen deficit in the blood stream produces blue coloration of the lips and skin and hence the term blue baby. More severe cases results in death. The health impacts to infants subject to chronic oxygen deprivation, as a result of nitrate consumption in drinking water, which do not result in mortality are unknown. The condition is often misdiagnosed and is believed to be under reported. A survey of hospital discharge records by Department of Health Services (DHS) between 1983 and 1995 revealed 97 cases of methemoglobinemia in children younger than one year. The database, however, was incomplete and it could not be determined how many cases were attributable to consumption of nitrate contaminated groundwater. Other chemicals that can lead to these conditions are aerosols deodorizer and certain pharmaceuticals.

Water systems impacted with nitrate exceeding the MCL must be blended with uncontaminated water, treated by ion exchange, or closed. The 1988 State Water Board report to the legislature stated that the
USEPA estimated the annual increase in household water bill to treat contaminated water at between $77 to $340 for water systems of 100 to 1,000,000 people served.

Areas of intensive crop production, especially crops with a high nitrogen demand (e.g. vegetables), are known to have or are suspected of having nitrate at elevated levels in the groundwater (e.g. Salinas Valley). Groundwater in crop production areas become contaminated with nitrate when nitrogen fertilizers are applied at rates in excess of the utilization capacity by the crop and along with inefficient irrigation or high rainfall leach the nitrate to groundwater. Other factors which contribute are a shallow aquifer, the absence of a restricting layer to vertical migration of nitrate, permeable soils and poor well construction.

In 1993, the Regional Water Board conducted a study of groundwater below five “typical well run” dairies in the vicinity of Hilmar. The average nitrate concentration was 49 mg/L and a maximum value of 250 mg/L was detected. This is well above the drinking water standard of 10 mg/L. Conditions were conducive to migration of nitrates to groundwater as soils are permeable (sandy) and the water table is shallow (4 to 25 below ground surface). There are 1600 dairies in the Central Valley with approximately 1 million head of cows. Regulatory programs are focused at protecting surface waters. At present the Board is requiring groundwater monitoring at approximately 20 dairies. However, there are no sites undergoing remediation.

The Basin Plan recognizes the contamination of groundwater by nitrate as a critical issue and recommends that the State Water Board take the lead in developing programs for the protection of groundwater from nitrate contamination. In 1995 the State Water Board assembled committees of technical advisors to review the Non Point Source Management Plan and to advise the State Water Board with respect to compliance with the federal Coastal Zone Management Act. Several committees dealt, in one form or another, with the issue of nitrate in groundwater. However, no new initiatives resulted from this process. With respect to septic systems, the Regional Water Board has dealt with these on a case-by-case basis by prohibiting discharge from a service area which has become problematic. Twenty six prohibitions have been instituted by the Regional Water Board. The Basin Plan contains guidelines for use of septic tank systems in developments. Staff has encouraged counties to adopt and enforce ordinances that are
consistent with the guidelines. With respect to nitrate impacted groundwater from crop production, no programs are in place and no enforcement cases have been brought before the Board.

Priority: High

Primary Action: Identify areas impacted with nitrates, identify the source of the nitrates, develop strategies to reduce impacts.

Implementation Requirements for proposed Primary Action:

1) Staff -- 0.3 PY for FY98-99, 0.4 PY for FY99-00, 0.4 PY for FY00-01

2) Contract(s) -- $10,000 per year

3) Source(s) -- Regional Water Board and State Water Board

Augmented Action: In absence of a uniform statewide program for dealing with nitrate in groundwater, the Regional Water Board should develop a program to address this issue.

Alternatively, staff could review the situation, discuss options with stakeholders and come back to the Regional Water Board with a recommendation on how best to address this issue. This report would require 1 PY to prepare. It could be completed in one year.

Implementation Requirements for proposed Augmented Action:

1) Staff -- 2.0 PY

2) Contract(s) -- $50,000

3) Source(s) -- State Water Board

Issue No. 13: Sediments

Discussion: With each rainfall, the surface waters of the basin run brown implying that there is a large quantity of sediments in the water. No review of potential sediment sources has been done. Improperly graded subdivisions are believed to contribute large quantities of sediment as do eroding roads, grazing, and other activities. These sediments may be impairing the municipal, recreational and habitat beneficial uses of
affected waterbodies. The Regional Water Board should investigate these issues.

Priority: Low

Primary Action: None

Implementation Requirements for proposed Primary Action: None

Augmented Action: In accordance with the Erosion/Sedimentation guidelines in the Basin Plan, conduct a review of potential sedimentation sources and develop management practices as necessary.

Implementation Requirements for proposed Augmented Action: 1) Staff -- 2.0 PY

2) Contract(s) -- $0

3) Source(s) -- State Water Board
RESPONSE TO COMMENTS
1998 TRIENNIAL REVIEW
OF THE
WATER QUALITY CONTROL PLAN FOR THE
TULARE LAKE BASIN

Commenters:

1. Mr. Robert E. Beehler, Field Office Manager, United States Department of the Interior, Hollister
2. Mr. Jeffrey B. Misenheimer, Wastewater Superintendent, City of Tulare, Tulare
3. Ms. Rosa Lau-Staggis, Environmental Control Officer, and Ms. Judi Tapia, Supervising Environmental Control Officer, City of Fresno, Wastewater Management Division, Fresno
4. Mr. Lynden Garver, Assistant Manager, Kings River Conservation District, Fresno
5. Mr. David L. Stringfield, Principal, and Ms. Penny L. Carlo, Carollo Engineers, Fresno
6. Mr. Lewis R. Nelson, Public Works Manager, City of Visalia, Visalia
7. Mr. Raul M. Rojas, Public Works Director, City of Bakersfield, Bakersfield
8. Dr. David W. Kay, Senior Environmental Specialist, Southern California Edison, Rosemead
9. Mr. Terry Oda, Chief, United States Environmental Protection Agency, Region IX, CWA Standards and Permits Office, San Francisco
10. Mr. Scott Smith and Mr. Warren Gross, BSK & Associates, Fresno

Following are the responses to comments received regarding the 1998 Triennial Review of the Basin Plan. Comments are summarized in italics.

Mr. Robert E. Beehler, Field Office Manager, United States Department of the Interior, Hollister

1. Develop region-wide nonpoint source management measures.

The Water Quality Control Plan for the Sacramento and San Joaquin Rivers and the Water Quality Control Plan for the Tulare Lake Basin contain significant descriptions of programs that are implemented to address nonpoint source problems. Both Basin Plans also reference the statewide Nonpoint Source Management Plan which describes the statewide framework for working on nonpoint source problems. The statewide nonpoint source management plan is currently being updated, as part of the process of addressing Coastal Zone Reauthorization Act requirements. Both Basin Plans acknowledge that nonpoint source problems are the most significant water quality problems that need to be addressed. Specific nonpoint source concerns have been identified as priority issues in the triennial review workplan. As these issues are worked on, specific management measures will be developed. If there are other nonpoint source issues which have not been identified, the Bureau of Land Management should submit the information supporting those concerns so that staff may evaluate the issues for the triennial review.

2. Develop riparian corridor protection policy.

The Regional Board issues water quality certification or permits for dredged and filled materials that can contain conditions that protect riparian habitat but has no general policies or recommendations on riparian corridors. Riparian corridors serve as natural filters as well as habitat and the Basin Plan could recognize and set forth policies to protect these areas. This has been added as a low priority issue on the triennial review workplan.
3. **Develop water quality objectives to protect rare, threatened or endangered species beneficial use.**

The Basin Plan designates certain waters as suitable for supporting habitat necessary for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered. However, the Basin Plan has not identified special water quality objectives to protect those uses and staff is unaware of any special needs. The Bureau of Land Management staff should submit any information that they are aware of that indicates that rare, threatened or endangered species require water quality objectives that are different than those contained in the Basin Plan. Staff will make a determination whether to add this item to the priority list if information is submitted.

4. **Develop abandoned mine policy.**

Abandoned mines have not been identified as a significant source of pollutants in the Tulare Lake Basin. However, this is a recognized water quality concern in the Sacramento River watershed and has been added as an issue in the triennial review for the Water Quality Control Plan for the Sacramento and San Joaquin Rivers. Any policies or programs developed as a result of this issue within the Region will likely be extended to include the Tulare Lake Basin.

5. **Involvement in any TMDL planning and analysis for Panoche and San Carlos Creeks.**

Any TMDL planning and analysis for Panoche and San Carlos Creeks will involve the U.S. Bureau of Land Management. As the Regional Board is not committed to starting work on the TMDL until 2004, this has been added as a low priority issue on the triennial review workplan.

Mr. Jeffrey B. Misenheimer, Wastewater Superintendent, City of Tulare, Tulare

6. **Develop an electrical conductivity credit for calcium, potassium, and magnesium.**

An electrical conductivity effluent limit issue has been added to the triennial review workplan.

7. **Establish a limit for total pounds of salt discharge requirement in lieu of EC discharge requirement.**

An electrical conductivity effluent limit issue has been added to the triennial review workplan.

Ms. Rosa Lau-Stages, Environmental Control Officer, and Ms. Judi Tapia, Supervising Environmental Control Officer, City of Fresno, Wastewater Management Division, Fresno

8. **Designate agricultural runoff a point source discharge.**

Federal regulations define return flows from irrigated agriculture and agricultural storm water runoff as nonpoint sources for the purpose of issuing NPDES permits [40 CFR 122]. State regulations allow the Regional Board to place requirements on any discharge of wastes. However, the effect of specific agricultural management practices, such as growing corn versus almonds, are not well understood and no plans have been developed to regulate these discharges. The Regional Board addresses this type of activity on an individual basis as pollution problems are found. Agricultural practices will be reviewed as part of the Groundwater Assessment issue and, if needed, policies for regulation of agricultural runoff will be developed.
9. Hold municipal uses to [salinity] standards relative to their contribution to the [basinwide salt] problem.

Salinity standards and effluent limits consider salinity increase through reasonable use and varies by type of dischager. As assessment of salinity increases due to use has been included in the Electrical Conductivity Effluent Limit issue.

10. Disallow the practice of putting new agricultural lands into production until a solution to the salt load issue is found.

The California Water Code does not give the Regional Board authority over land use. In addition, agricultural land use appears to be declining as information supplied by the Fresno Wastewater Management Division from the Agricultural Census indicates that the acreage of farms, cropland, harvested cropland and irrigated lands decreased from 1982 to 1992.

11. It is unclear from the Basin Plan whether the 4 micromhos per cm [maximum average annual increase in salinity measured as electrical conductivity for the Kings River Hydrographic Unit] is an average hydrographic unit allowable increase or a point source limit as it is currently being applied. This should be clarified in the Basin Plan reevaluation.

The basin plan recognizes that the Tulare Lake Basin is a closed basin and in accordance with State Board Resolution 68-16 allows a maximum incremental increase in electrical conductivity. This groundwater quality objective applies generally to the entire study area. However, to ensure that Basin groundwater is not degraded over this maximum, waste discharge requirements include this as the water quality objective at the point of compliance. A higher incremental increase may be allowed for a specific area within the basin if a demonstration is made that the discharger has implemented best practicable treatment or control of the discharge, the subarea is properly managed by the discharger, and it is found to be in the public interest.

12. The maximum average annual increase in salinity policy should be removed until electrical conductivity background information of all areas and activities is updated.

Removal would require an amendment that must be preceded by an investigation. An investigation is already part of the proposed Groundwater Quality Objectives for Salinity issue. A mechanism to consider specific cases in the interim already exists and explained in response to Comment No. 11.

13. Extensive sampling of background EC is needed to determine the average annual increase in salinity. Survey should include all land users, point and nonpoint source dischargers, to determine sectors and activities that contribute salt loading to the Tulare Lake Basin.

Comment is noted and has been included in the Groundwater Assessment issue.

14. Reevaluate the EC limit for wastewater treatment facilities. It seems that municipal treatment facilities are shouldering an unfair portion of the mitigation efforts in relation to their contribution to the overall problem.

The First Edition of the Basin Plan placed the burden of implementing the Basin Plan on municipal and industrial treatment facilities. For nonpoint sources, the First Edition promoted the formation of an Agricultural Water Quality Management Group which would be locally controlled and would assist in the evaluation of data collection programs, agricultural drainage water disposal, overdraft elimination, and salinity control in the groundwater. This group was unsuccessful in developing any programs. Current direction regarding nonpoint sources favors formation of watershed groups which would involve all stakeholders. The Groundwater Assessment issue proposed by staff in the workshop
notice moves in this direction. The municipal treatment facilities must become involved in the watershed groups to resolve this issue.

15. Characterization of EC contributors should be done and a surcharge should be assessed to fund the valley drain based on salt load contribution.

The California Water Code does not give the Regional Board the authority to surcharge dischargers for the purpose of building a valleywide drain. However, the Regional Board supports any efforts to construct a valleywide drain to remove salt-laden wastewater from the Basin under the following conditions:

Σ All toxicants would be reduced to a level which would not harm beneficial uses of receiving water.

Σ The discharge would be governed by specific discharge and receiving water limits in an NPDES permit.

Σ Long-term continuous biological monitoring would be required.

16. Reevaluate the EC limit for wastewater treatment facilities by applying the 500 mmhos/cm increase to receiving rather than source water.

The 500 mmhos/cm increase to source water reflects that water usage leads to some EC increase. However, the State's anti-degradation policy states that "[w]henever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." Applying the increase of 500 mmhos/cm to receiving water rather than source water would eventually render most groundwater unusable, would unreasonably affect the present and anticipated beneficial use of such water and is be unjustifiable under the State's anti-degradation policy.

17. Reevaluate the EC limit for wastewater treatment facilities to take into consideration water conservation measures.

The EC limit should allow for reasonable use of water. If measures to improve efficiency of water use by domestic users has resulted in consistently less water use and more concentrated wastewater, the EC limit should reflect this. Water conservation measures will be investigated as part of the effluent conductivity limit issue in the triennial review work plan.

18. Add provisions to the Basin Plan to describe the mechanism to obtain interpretation of the Basin Plan and to challenge those interpretations.

The usual mechanism to obtain interpretations and to challenge basin plan interpretations is either through the waste discharge permitting process or through the Triennial Review process. In the permitting process, staff interpretations may be disputed before the Board at the time of adoption of the permit. If unsatisfied with the position of the Board, the permit may be appealed to the State Board. For interpretations which are outside of the permitting process, interested parties may request clarifications and modifications of Board policies at the time of the Triennial Review. Policy is either clarified in the responses or included as issue for further investigation in the Triennial Review priority list. As Regional Board resources permit, these issues will be addressed. Issues
brought up between triennial reviews are noted but, because of limited staff resources, can not be addressed prior to the next triennial review.


I. Salinity in the Lower Kings River: This continues to be an issue, but has a more narrow focus than before. The River has problems meeting water quality objectives during dry and critically dry years. Therefore, studies identifying the causes of exceedences need to be conducted during the appropriate environmental conditions. In the meantime, sufficient information exists to identify high salinity discharges into the Kings River and actions may be taken to remove these discharges.

II. Beneficial Uses of Surface Waters: No work was done in this on this low priority issue.

III. Ground Water Monitoring Network: This continues to be an issue but no work has been performed to date.

IV. Ground Water Contamination: This was merged with the Ground Water Monitoring Network issue to form the Groundwater Assessment issue proposed in the current Triennial Review. No work has been performed to date.

V. Ground Water Quality Objectives for Salinity: This continues to be an issue that depends on implementation of the Ground Water Monitoring Network, so no work has been done yet.

VI. Dissolved Oxygen Objectives: Information submitted by the Kings River Conservation District indicates that Reach III (Pine Flat Dam to the Friant-Kern Canal) of the Kings River cannot meet dissolved oxygen objectives. The specific conditions when this occurs must be identified and the objectives should be revised accordingly.

Mr. Lynden Garver, Assistant Manager, Kings River Conservation District, Fresno

20. Additional studies regarding the salinity in the Lower Kings River are unnecessary. Sufficient information exists to identify the high salinity dischargers and issue cease and desist orders.

The poor quality of the Lower Kings River during dry and critically dry years may not be due entirely to the high salinity dischargers. Therefore, additional studies are proposed for appropriate type water years. In the meantime, the Regional Board may proceed with actions to remove the high salinity discharges from the River.

21. Most local water agencies who adopted groundwater management plans are only monitoring groundwater levels and perhaps electrical conductivity. More complex laboratory analysis will be cost prohibitive and would require a long-term commitment by the Regional Board, local agencies, and property owners.

The most critical Regional Board need is a monitoring network for electrical conductivity. More complex needs and their funding are a concern that has been incorporated into the Groundwater Assessment issue.

22. Most monitoring programs are designed to use agricultural production wells and the construction details may not be available.

The Regional Board considers the most important component of the groundwater monitoring network to be tracking of trends in electrical conductivity. Production wells that are used in the
network will need to be evaluated for suitability for this purpose. This concern has been incorporated into the Groundwater Assessment issue.

23. *Seasonal and annual fluctuations of the groundwater level may result in a variance in the concentration of many of the chemicals which the Regional Board may wish to monitor.*

The Regional Board agrees that fluctuations in groundwater level may result in a variance in water quality. This is part of the Groundwater Assessment issue.

24. *Most agencies and land owners will want to know the ramifications of a groundwater quality monitoring program before they agree to cooperate.*

This concern is understood and will need to be addressed as part of the Groundwater Assessment issue.

25. *The issue of re-investigating the salinity objectives should be given very low priority if not removed from the plan entirely. Finding a method of salt removal from the valley should be given high priority.*

A method of salt removal from the valley is also an issue with other programs, such as the Central Valley Improvement Program. The Regional Board believes that a valleywide drain to carry salts out of the valley is the best technical solution to the water quality problems of the Tulare Lake Basin. Until the drain is constructed, salinity increases in the water supply should be minimized to extend the life of the water resources. Reevaluation of the groundwater quality objectives for salinity is included as part of the implementation plan for controlling salinity in the Basin.

26. *If the issue of reevaluating the salinity objectives for groundwater is to reduce the rate of salt accumulation, a method of monitoring the progress is needed.*

The Regional Board recognizes that a groundwater monitoring network is needed to monitor the rate of salt accumulation in the Basin. This is part of the Groundwater Assessment issue.

27. *If groundwater objectives for salinity are not met, what action would be provided under the plan.*

The implementation program developed to manage the rate of salinity increase would need to be reevaluated and, if practicable, modified to better control the salinity increases. If all practicable measures had been implemented the objectives would need to be reevaluated. This issue would be part of a future Triennial Review.

28. *The dissolved oxygen objective for Reach III of the Kings River should be a minimum of 7.0 mg/l.*

This comment has been noted and has been incorporated into the Dissolved Oxygen Objectives issue.

Mr. David L. Stringfield, Principal, and Ms. Penny L. Carlo, Carollo Engineers, Fresno

29. *Calcium, magnesium, and potassium ions are beneficially used by agriculture so an EC credit should be allowed for municipal discharges with these constituents.*

See response to Comment #6.

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Mr. Lewis R. Nelson, Public Works Manager, City of Visalia, Visalia

30. Same comment as #29.

See response to Comment #29.

Mr. Raul M. Rojas, Public Works Director, City of Bakersfield, Bakersfield

31. Same comment as #29.

See response to Comment #29.

Dr. David W. Kay, Senior Environmental Specialist, Southern California Edison, Rosemead

32. The WARM and COLD beneficial uses for the Kern River above and below Lake Isabella should be clarified to acknowledge temporal shifts in natural instream water temperatures.

By combining both WARM and COLD, the Regional Board recognizes that these reaches may shift from supporting cold water habitat during certain parts of the year to supporting only warm water habitat during other parts of the year. In addition, the Basin Plan states that “[i]n some cases a beneficial use may not be applicable to the entire body of water. In these cases the Regional Water Board’s judgment will be applied.” Since the designated beneficial uses for the Kern River in, above and below Lake Isabella are WARM and COLD, Southern California Edison’s concerns are met and no changes to the beneficial uses are needed.

Mr. Terry Oda, Chief, United States Environmental Protection Agency, Region IX, CWA Standards and Permits Office, San Francisco

33. Supports the Groundwater Assessment issue as a high priority.

This issue has been prioritized accordingly.

34. The Groundwater Assessment should address salt accumulation from agricultural drainage waters and explore alternative discharge strategies.

This concern has been incorporated into the Groundwater Assessment issue.

35. Regulatory programs dealing with discharge contributions from dairies should also be integrated into the assessment.

This concern has been incorporated into the Groundwater Assessment issue.


This issue has been of medium priority relative to the salt issues and is not identified for funding.

37. Development of guidelines for individual disposal systems should include a review of county efforts to regulate engineered systems.

This is included in the scope of the Individual Disposal Systems issue.
38. Clarification is needed for the tributary language which reads, “The beneficial uses of any specifically identified water body generally apply to its tributary streams. In some cases a beneficial use may not be applicable to the entire body of water. In these cases the Regional Water Board’s judgment will be applied.” While added to the priority list, this language has been implemented without problems for years and is of low priority for revision.

39. The Board should consider plans for development and implementation of TMDLs for the Tulare Lake Basin.

Since the TMDLs for the Tulare Lake Basin have already been scheduled to start in 2004, this concern has been added as a medium priority issue on the triennial review work plan.

40. EPA may be re-evaluating the criteria included in the proposed California Toxics Rule for selenium, mercury, PCP, and/or other pollutants, in response to concerns raised by the U.S. Fish & Wildlife Service. For its next triennial review, the Board should consider adopting water quality objectives for these constituents.

Federal standards are applicable statewide. When changes occur, the Central Valley Regional Board will act consistent with statewide direction provided by the State Water Resources Control Board.

Mr. Scott Smith and Mr. Warren Gross, BSK & Associates, Fresno

41. Exempt confined animal facilities from the requirement that new manure retention ponds be designed, constructed, and operated to ensure that the invert of the pond will be at least 3 feet above the highest elevation of underlying groundwater for facilities where it is shown that (1) the quality of underlying groundwater is poorer, for each constituent of concern, than that of the wastewater, and (2) that the discharge does not cause the poor quality ground [water] to adversely impact downgradient groundwater quality.

Added as an issue on the priority list.
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COMBINED SWRCB/CIWMB REGULATIONS
DIVISION 2, TITLE 27

Section Title Key:
The code "SWRCB -" at the beginning of a section title indicates the section is promulgated by the State Water Resources Control Board;

The code "CIWMB -" at the beginning of a section title indicates the section is promulgated by the California Integrated Waste Management Board;

The code "(T14: $###)" following the title of a CIWMB promulgated section indicates the section's former location ($###) in Division 7 of Title 14, California Code of Regulations (CCR). Such a code following the title of an SWRCB-promulgated section indicates the source (in Title 14) of a water quality protection requirement the SWRCB has incorporated, pursuant to AB-1220;

The code "(C15: $###)" or "(C15: $###(#))" following the title of a SWRCB-promulgated section indicates the section's former location ($###) in Chapter 15 of Division 3 of Title 23, CCR;

The code "(new)" following the title of any section indicates that the section is newly promulgated.

Division 2. Solid Waste.
Subdivision 1. Consolidated Regulations for Treatment, Storage, Processing, or Disposal of Solid Waste
Chapter 1. General

Article 1. Purpose, Scope and Applicability of this Subdivision
20005. CIWMB - Purpose Scope and Applicability of CIWMB Standards. (T14:$17601)
(a) Regulatory standards promulgated by the California Integrated Waste Management Board (CIWMB) in this division implement only the jurisdiction of the CIWMB, as set forth in Division 30, Commencing with §40000, of the PRC, and shall not be construed by the CIWMB or the enforcement agency (EA) in a manner that would infringe upon or interfere with the administration or implementation of the comprehensive program of regulatory standards promulgated by the SWRCB in this title for the protection of water quality, pursuant to Division 7, commencing with §13000, of the Water Code.

(b) The purpose for the CIWMB standards in this subdivision is to protect public health and safety and the environment. The CIWMB standards in this chapter do not address air or water quality aspects of the environment that are regulated by other state or local agencies.

(c) The standards promulgated by the CIWMB in Chapters 1, 2, 3, and applicable portions of Chapter 4 shall apply to all disposal sites meaning active, inactive closed or abandoned, as defined in §40122 of the Public Resources Code including facilities or equipment used at the disposal sites. Responsibility for enforcing state minimum standards as defined by the CIWMB shall be administered by the EA in consultation as deemed appropriate with the Regional Water Quality Control Board or other oversight agency.


§20010. Statutory Mandate. (non-regulatory) [Reserved]
20012. SWRCB - Reliance Upon CIWMB Requirements. (new)

(a) Where necessary to protect water quality, the Regional Water Quality Control Board (RWQCB) can implement, in coordination with the enforcement agency (EA) or, as appropriate, the California Integrated Waste Management Board (CIWMB), appropriate standards promulgated by the CIWMB in this subdivision, provided that the action does not duplicate or conflict with any action taken by the EA.

(b) Where necessary to protect water quality, the RWQCB can cite the standards promulgated by the CIWMB in this subdivision as evidence of a violation of standards promulgated by the SWRCB or of Waste Discharge Requirements (WDRs) in any ensuing enforcement proceeding, provided that the violation does not duplicate or conflict with any action by the EA and that such enforcement proceeding is based upon the authority of the RWQCB under Division 7 of the Water Code.


20014. CIWMB - Reliance Upon SWRCB Requirements. (new)

(a) Where necessary to protect aspects of the public health and safety and the environment, other than water quality, the EA may implement, in coordination with the RWQCB and the CIWMB, appropriate standards promulgated by the SWRCB in this subdivision provided that the action is not duplicative of or in conflict with any action taken by the RWQCB.

(b) Where necessary to protect aspects of the public health and safety and the environment, other than water quality, the EA may cite the standards promulgated by the SWRCB in this subdivision as criteria to cause a site to correct a violation of the standards promulgated by the CIWMB or of a Solid Waste Facility Permit (SWFP).

The EA may also reference the aforementioned criteria as evidence of a violation of appropriate CIWMB promulgated standards or of a SWFP in any ensuing enforcement proceeding, provided that the violation is not duplicative of or in conflict with any action by the RWQCB and such enforcement proceeding is based upon the authority of the EA under Division 30 of the Public Resources Code.


§20020. How to Use Combined Regulations. (non-regulatory) [Reserved]

20030. CIWMB - Authority. (T14: §17200)

The regulations contained herein are promulgated pursuant to Public Resources Code (PRC) §§43020, 43020.1, 43021, 43030, 43101, 43103 and Health and Safety Code §4520. No provision in this Division shall be construed as a limitation or restriction upon the CIWMB's right to exercise discretion which is vested in it by law. Nor shall any provision be construed to limit or restrict counties and cities from promulgating enactments which are as strict as or stricter than the regulations contained in this Division. However, no city or county may promulgate enactments which are inconsistent with the provisions of this Division. Any reference in this chapter to an EA shall be deemed to mean the EA created pursuant to PRC §§43200 - 43219.


20040. CIWMB - Compliance with Laws and Regulations. (T14: §17201)

Nothing in these standards shall be construed as relieving an owner, operator, or designer from the obligation of obtaining all required permits, licenses, or other clearances, and complying with all orders, laws, regulations, or other requirements of other approval, regulatory or enforcement agencies, such as, but not limited to the Department of Toxic Substances Control, local health entities, water and air quality control boards, local land use authorities, fire authorities, etc.
20050. CIWMB - Purpose, Intent. (T14: §17202-17203)

[Note: This section will be amended upon the adoption of future regulations pertaining to tiers, transfer stations, operations, etc.]

(a) The purpose of the regulations in Chapters 1, 2, and 3 is to promote the health, safety and welfare of the people of the State of California, and to protect the environment by establishing minimum standards for the handling and disposal of solid wastes at disposal sites.

(b) By adopting these standards, the CIWMB hereby sets forth performance standards for solid waste disposal sites which are of state concern, as required by PRC §§43020 and §43021, and sets forth minimum substantive requirements for operators' submission of information concerning individual solid waste disposal sites.


History
1. Amendment filed 2-21-78; effective thirtieth day thereafter (Register 78, No. 8).
2. Change without regulatory effect amending section filed 5-17-91 pursuant to section 100, title 1, California Code of Regulations (Register 91, No. 27).

20060. CIWMB - Applicability of Federal Subtitle D Related Standards to Small Landfills. (T14: portions of §17258.1)

MSWLF units that meet the conditions of 40 CFR 258.1(f)(1) and received waste after October 9, 1991 but stopped receiving waste before October 9, 1997, are exempt from all the requirements promulgated as a result of 40 CFR 257 and 258, except the final cover minimum standards specified in Section 21140 and all other applicable requirements of Chapters 3 and 4, of this subdivision. The final cover must be installed by October 9, 1998.

Owners and operators of MSWLF units described in this paragraph that fail to complete cover installation by October 9, 1998 will be subject to all the requirements of this subdivision, unless otherwise specified.


20080. SWRCB - General Requirements. (C15: §2510)

(a) Scope—The regulations in this subdivision that are promulgated by the State Water Resources Control Board (SWRCB) pertain to water quality aspects of discharges of solid waste to land for treatment, storage, or disposal. The SWRCB-promulgated regulations in this subdivision establish waste and site classifications and waste management requirements for solid waste treatment, storage, or disposal in landfills, surface impoundments, waste piles, and land treatment units. Requirements in the SWRCB-promulgated portions of this subdivision:

(1) Minimum standards—are minimum standards for proper management of each waste category. Regional boards may impose more stringent requirements to accommodate regional and site specific conditions;

(2) MSW Landfill Requirements—as they apply to MSW landfills, are superseded by any more stringent requirements in SWRCB Resolution No. 93-62 (Section 2908, Title 23 of this code) or in the federal MSW regulations (40CFR258);

(3) Utilize Abbreviated Internal References—make reference only to requirements of the sections within this subdivision, unless otherwise stated. Under this internal reference convention: (A) any unenumerated paragraph reference in this division [e.g., ".(c)"] or ".(d)(2)(A-D)" (i.e., subsections A through D, inclusive) is to be found in the same section as the referring subsection; and (B) any enumerated reference that does not
implicitly identify a source outside this subdivision [e.g., "§20200", "§20220(b)", or "Article 2, Subchapter 3, Chapter 3"] is to be found in this subdivision; and

(4) Contain Nonregulatory Notes and Examples—contain some nonregulatory language that is needed in a body of multi-agency regulations such as this in order to improve clarity and continuity. Such non-regulatory language is always italicized, is always set off from adjacent regulatory text by parentheses or brackets, serves an obviously explanatory function, and typically begins with either "Note:" or "e.g.,". In the SWRCB-promulgated sections of this subdivision, such italicized notes and examples are intended only to provide the reader with useful guidance, and do not constitute standards having regulatory effect.

(b) Engineered Alternatives Allowed—Unless otherwise specified, alternatives to construction or prescriptive standards contained in the SWRCB-promulgated regulations of this subdivision may be considered. Alternatives shall only be approved where the discharger demonstrates that:

(1) the construction or prescriptive standard is not feasible as provided in .(c); and

(2) there is a specific engineered alternative that:

(A) is consistent with the performance goal addressed by the particular construction or prescriptive standard; and

(B) affords equivalent protection against water quality impairment.

(c) Demonstration [for .(b)—To establish that compliance with prescriptive standards in this subdivision is not feasible for the purposes of .(b), the discharger shall demonstrate that compliance with a prescriptive standard either:

(1) is unreasonably and unnecessarily burdensome and will cost substantially more than alternatives which meet the criteria in .(b); or

(2) is impractical and will not promote attainment of applicable performance standards.

The RWQCB shall consider all relevant technical and economic factors including, but not limited to, present and projected costs of compliance, potential costs for remedial action in the event that waste or leachate is released to the environment, and the extent to which ground water resources could be affected.

(d) Existing & New Units—Units which were operating, or had received all permits necessary for construction and operation, on or before November 27, 1984, are designated as "existing" Units. This includes disposal sites classified under previous regulations and unclassified Units. Dischargers shall continue to operate existing Units under existing classifications and WDRs until those classifications and requirements are reviewed in accordance with §21720(c). Existing Units shall be closed and maintained after closure according to Subchapter 5, Chapter 3 of this subdivision (§20950 et seq.). All other Units (including expansions and reconstructions of existing Units initiated after November 27, 1984) are "new" Units. For discharges at new Units, the discharger shall comply with all applicable provisions of this division, as summarized in Table 3.1 [of Article 3, Subchapter 2, Chapter 3 of this subdivision] and in §20310(d). Pending review and reclassification, the following SWRCB-promulgated provisions of this division shall apply to existing Units:

(1) except with regard to Units which were closed, abandoned, or inactive on or before November 27, 1984 [such Units are addressed separately, under .(g)], all dischargers are required to be in compliance with the monitoring program requirements [in Article 1, Subchapter 3, Chapter 3, Subdivision 1 of this division (§20380 et seq.)];

(2) dischargers may be required to submit additional technical and monitoring reports to the RWQCB as determined to be necessary on a case by case basis.

(e) Reclassification—In reviewing WDRs for existing Units, the RWQCB shall consider the results of monitoring programs developed under .(d)(1) and technical and monitoring reports submitted under .(d)(2). Existing Units shall be reclassified according to the geologic siting criteria in Article 3, Subchapter 2, Chapter 3, Subdivision 1 of this division (§20240 et seq., as summarized in Table 3.1 of that article) and shall be required to comply with applicable SWRCB-promulgated construction standards in Article 4, Subchapter 2, Chapter 3,
Subdivision 1 of this division [as summarized in §20310(d)] as feasible. To establish that retrofitting is not feasible, the discharger shall be required to make the demonstrations in (b) and (c).

(f) WDRs Implement Regulations—The RWQCB shall implement the SWRCB-promulgated regulations in this subdivision through the issuance of WDRs for Units.

(g) CAI Units—Persons responsible for discharges at Units which were closed, abandoned, or inactive on or before November 27, 1984 (CAI Units), may be required to develop and implement a detection monitoring program in accordance with Article 1, Subchapter 3, Chapter 3, Subdivision 1 of this division (§20380 et seq.). If water quality impairment is found, such persons may be required to develop and implement a corrective action program under that article.

(h) Mining Waste—Discharges of mining waste, as defined in §22470(a), shall be regulated only by the provisions of Article 1, Subchapter 1, Chapter 7, Subdivision 1 of this division (§22470 et seq.) and by such provisions of the other portions of this subdivision as are specifically referenced in that article.

(i) Combined SWRCB/CIWMB Solid Waste Landfill Regulations—The California Integrated Waste Management Board (CIWMB) and the SWRCB have promulgated the combined regulations contained in this division. For clarity, in moving the modified sections from their former location (in Chapter 15, Division 3, Title 23 of this code):

(1) Section Title Coding—the title of each SWRCB-promulgated section in the combined regulations begins with “SWRCB - ” and ends with the section number (in parentheses) that section had in Title 23—e.g., the notation “(C-15: §2540)” following the section title signifies that the subject section is derived from §2540, Chapter 15, Division 3, Title 23 of this code, as that chapter existed prior to July 18, 1997; and

(2) Paragraph Subtitles—subtitles have been added at the beginning of many paragraphs, to assist the reader in quickly finding specific portions of the SWRCB’s requirements that address a particular issue.


20090. SWRCB - Exemptions. (C15: §2511)

The following activities shall be exempt from the SWRCB-promulgated provisions of this subdivision, so long as the activity meets, and continues to meet, all preconditions listed:

(a) Sewage—Discharges of domestic sewage or treated effluent which are regulated by WDRs issued pursuant to Chapter 9, Division 3, Title 23 of this code, or for which WDRs have been waived, and which are consistent with applicable water quality objectives, and treatment or storage facilities associated with municipal wastewater treatment plants, provided that residual sludges or solid waste from wastewater treatment facilities shall be discharged only in accordance with the applicable SWRCB-promulgated provisions of this division.

(b) Wastewater—Discharges of wastewater to land, including but not limited to evaporation ponds, percolation ponds, or subsurface leachfields if the following conditions are met:

(1) the applicable RWQCB has issued WDRs, reclamation requirements, or waived such issuance;

(2) the discharge is in compliance with the applicable water quality control plan; and

(3) the wastewater does not need to be managed according to Chapter 11, Division 4.5, Title 22 of this code as a hazardous waste.

(c) Underground Injection—Discharges of waste to wells by injection pursuant to the Underground Injection Control Program established by the United States Environmental Protection Agency (USEPA) under the Safe Drinking Water Act, [42 U.S. Code Section 300(h), see Title 40 of the Code of Federal Regulations, Parts 144 to 146, 40 CFR 144 to 146].

(d) RWQCB Cleanup Actions—Actions taken by or at the direction of public agencies to cleanup or abate conditions of pollution or nuisance resulting from unintentional or unauthorized releases of waste or pollutants to
the environment; provided that wastes, pollutants, or contaminated materials removed from the immediate place of release shall be discharged according to the SWRCB-promulgated sections of Article 2, Subchapter 2, Chapter 3, Subdivision 1 of this division ($20200 et seq.); and further provided that remedial actions intended to contain such wastes at the place of release shall implement applicable SWRCB-promulgated provisions of this division to the extent feasible.

(c) **Gas Condensate**—Discharges of condensate from methane gas recovery operations at classified Units if the following conditions are met:

1. condensate shall have no chemical additives which could adversely affect containment features, and shall consist only of water and liquid contaminants removed from gas recovered at a Unit;

2. except as otherwise provided in §20200(d) regarding MSW landfills, condensate shall either be discharged to a different landfill that has a leachate collection and removal system and that is operated under WDRs issued by the RWQCB, or returned to the Unit(s) from which it came; and

3. the discharger shall submit a report of waste discharge to the RWQCB, pursuant to Chapter 9, Division 3, Title 23 of this code, and shall discharge condensate only in compliance with WDRs.

(f) **Soil Amendments**—Use of nonhazardous decomposable waste as a soil amendment pursuant to applicable best management practices, provided that RWQCBs may issue waste discharge or reclamation requirements for such use.

(g) **Drilling Waste**—Discharges of drilling mud and cuttings from well drilling operations, provided that such discharges are to on site sumps and do not contain halogenated solvents, and further provided that, at the end of drilling operations, the discharger either:

1. removes all wastes from the sump; or

2. removes all free liquid from the sump and covers residual solid and semi solid wastes, provided that representative sampling of the sump contents after liquid removal shows residual solid wastes to be nonhazardous. If the sump has appropriate containment features, it may be reused.

(h) **Reuse**—Recycling or other use of materials salvaged from waste, or produced by waste treatment, such as scrap metal, compost, and recycled chemicals, provided that discharges of residual wastes from recycling or treatment operations to land shall be according to applicable provisions of this division.

(i) **Fully Enclosed Units**—Waste treatment in fully enclosed facilities, such as tanks, or in concrete lined facilities of limited areal extent, such as oil water separators designed, constructed, and operated according to American Petroleum Institute specifications.


§20100. [Reserved by SWRCB.]
§20110. [Reserved by SWRCB.]
§20120. [Reserved by SWRCB.]
§20130. [Reserved by SWRCB.]
§20140. [Reserved by SWRCB.]

**Chapter 2. Definitions**

**Article 1. Statutory Definitions**

20150. **CIWMB - General.** (T14:§17225, 17258.2)

Unless the context requires another construction, the definitions set forth in this chapter and in Division 30 of the Public Resources Code shall govern the construction of this Subdivision. No definitions which are present in
Division 30 of the Public Resources Code are repeated herein. Consequently, those definitions should be read in conjunction with the ones set forth herein.


_20163. SWRCB - Statutory Definitions._ (C15: §2600)

Except as otherwise indicated in this article, definitions of terms used in the SWRCB-promulgated portions of this subdivision shall be those set forth in Division 7 (commencing with Section 13000) of the Water Code, or Chapter 6.5 of Division 20 of the Health and Safety Code (commencing with Section 25100).


**Article 2. Specific Definitions**


[Note: This section contains the SWRCB's and the CIWMB's technical definitions, combined and listed in alphabetical order. Each agency is responsible for adopting its own definitions within this combined listing. Those terms in this section that are followed by "(CIWMB)" are adopted by the CIWMB; those followed by "(SWRCB)" are adopted by the SWRCB. Unless otherwise stated in a given regulation, it is the intent of the SWRCB and CIWMB that each agency's definitions function for the other agency (e.g., when the CIWMB uses a term adopted by the SWRCB, or vice versa, the term has the same meaning as defined by the agency that adopted the term).]

"Abandoned site" (CIWMB) means a site where there is no responsible party.

"Abandoned Vehicles" (CIWMB) includes vehicles, with or without motor power, including cars, trucks, trailers, mobile homes, buses, etc., left on public or private property for an extended period of time and usually in an inoperable or hazardous condition.

"Acceptance for filing" (CIWMB) means the enforcement agency has determined that the application package is complete and correct and the specified permit action time frames contained in Chapter 4 of this subdivision commence.

"Active" (CIWMB) for CIWMB promulgated sections means the period when waste is being accepted for disposal at a disposal site.

"Active Face" (CIWMB) means the working surface of a landfill upon which solid wastes are deposited during the landfill operation, prior to the placement of cover material.

"Active life" or "operating life" (SWRCB) means the period during which wastes are being discharged to a waste management unit. The active life continues until final closure of the waste management unit has been initiated pursuant to this subdivision. For surface impoundments, the active life includes any time when the impoundment contains liquid, including waste and leachate.

"Affected medium" (SWRCB) means any natural medium that consists of or contains waters of the state (e.g., ground water, surface water, or the unsaturated zone) that has been affected by a release from a waste management unit.

"Agricultural Solid Wastes" (CIWMB) include wastes resulting from the production and processing of farm or agricultural products, including manures, prunings and crop residues wherever produced.

"Airport" (CIWMB) means public-use airport open to the public without prior permission and without restrictions within the physical capacities of available facilities.

"Alternative Daily Cover" (CIWMB) see “cover material”.
“Annular Seal” (CIWMB) the seal placed in the space between the casing in a well and the wall of the hole, or between two concentric strings of casing, or between casing and tubing.

“Approval Agency” (CIWMB) includes any agency with regulatory powers regarding solid waste generation, collection, transportation, processing or disposal and includes, but is not limited to the CIWMB, the Department of Toxic Substances Control, California Regional Water Quality Control Boards, local air districts, local enforcement agencies, local health entities and local land use authorities.

“Approved closure plan” (SWRCB) means the portion of a waste management unit's (Unit's) final closure and post-closure maintenance plan that describes all actions necessary to prepare the Unit for post-closure maintenance, and that has been approved by the RWQCB and by any other state and local agencies having purview over that plan.

“Aquifer” (SWRCB) means a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.

“Attitude” (SWRCB) means either the orientation in space of a geologic structural feature or the structural element position of a geologic bed, stratum, fracture, or surface relative to the horizontal.

“Background” (SWRCB) means the concentrations or measures of constituents or indicator-parameters in water or soil that has not been affected by waste constituents or leachate from the waste management unit being monitored.

“Background Monitoring Point” (SWRCB) (as capitalized) means a well, device, or location specified in the waste discharge requirements at which monitoring for background water quality or background soil quality is conducted.

“Background plot” (SWRCB) means an area adjacent to a land treatment unit that can reasonably be expected to have the same, or similar soil conditions as were present at the land treatment unit prior to discharges of waste.

“Bailing” (CIWMB) includes the process of compressing and binding solid wastes.

“Bench” (CIWMB) means a terrace or comparatively level platform breaking the continuity of a slope.

“Best management practice(s)” (SWRCB) means a practice, or combination of practices, that is the most effective and feasible means of controlling pollution generated by nonpoint sources for the attainment of water quality objectives.

“Bird hazard” (CIWMB) means an increase in the likelihood of bird/aircraft collisions that may cause damage to the aircraft or injury to its occupants.

“Bulky Waste” (CIWMB) includes large items of solid waste such as appliances, furniture, large auto parts, trees, branches, stumps and other oversize wastes whose large size precludes or complicates their handling by normal collection, processing or disposal methods.

“CAI Units” (SWRCB) means waste management units that were closed, abandoned, or inactive prior to November 27, 1984.

“Capillary force(s)” (SWRCB) means the adhesive force between liquids and solids which, in the case of ground water hydrology, causes soil pore liquid to move in response to differences in matric potential. This effect causes ground water to rise from a saturated zone into the unsaturated zone, thereby creating a capillary fringe.

“Cell” (CIWMB) means that portion of compacted solid wastes in a landfill that is enclosed by natural soil or cover material during a designated period.

“Certified Engineering Geologist” (CIWMB) means a registered geologist, certified by the State of California, pursuant to section 7842 of the Business and Professions Code.

“CIWMB” (CIWMB) means the California Integrated Waste Management Board, which is the lead agency for implementing the State municipal solid waste permit program that is deemed to be adequate by US EPA under regulations published pursuant to sections 2002 and 4005 of RCRA.
“Classified waste management unit” or “classified Unit” (SWRCB) means a waste management unit (as defined in this section) that has been classified by a Regional Water Quality Control Board according to the provisions of Article 3 Subchapter 2, Chapter 3 of this division (§20240 et seq.).

“Classified Unit” — see “classified waste management unit” or “classified Unit”

“CLGB” — see “concentration limit”

“Closed Site” (CIWMB) means a disposal site that has ceased accepting waste and was closed in accordance with applicable statutes, regulations, and local ordinances in effect at the time.

“Closure” (SWRCB) means the process during which a waste management unit (Unit), or portion thereof, that is no longer receiving waste, is undergoing all operations necessary to prepare the Unit (or portion thereof, as appropriate) for post-closure maintenance in accordance with an approved plan for closure, or partial final closure as appropriate.

“COC” or “COCs” — see “Constituents Of Concern”

“Coefficient of variation” (SWRCB) means the standard deviation divided by the mean. It is a statistical measure of the dispersion of individual samples relative to the mean value of the samples.

“Collection” (CIWMB) means the act of collecting solid waste at the place of waste generation by an approved collection agent (public or private) and is distinguished from “removal.”

“Collection Vehicle or Equipment” (CIWMB) includes any vehicle or equipment used in the collection of residential refuse or commercial solid wastes.

“Commercial Solid Wastes” (CIWMB) include all types of solid wastes generated by stores, offices and other commercial sources, excluding residences, and excluding industrial wastes.

“Concentration limit” (SWRCB) means the value for a constituent specified in the water quality protection standard under §20390 and §20400, including but not limited to values for concentration, temperature, pH, conductivity, and resistivity. The term can apply to a concentration that exceeds the constituent’s background concentration [i.e., a “concentration limit greater than background (CLGB)” (SWRCB) as described under §20400].

“Concentration limit greater than background (CLGB)” — see “concentration limit”

“Confined animal facility” (SWRCB) means any place where cattle, calves, sheep, swine, horses, mules, goats, fowl, or other domestic animals are corralled, penned, tethered, or otherwise enclosed or held and where feeding is by means other than grazing.

“Constituent” (SWRCB) means an element or compound which occurs in or is likely to be derived from waste discharged to the waste management unit.

“Constituent(s) of concern” or “COC(s)” (SWRCB) means any waste constituent(s), reaction product(s), and hazardous constituent(s) that is reasonably expected to be in or derived from waste contained in a waste management unit.

“Construction and Demolition Wastes” (CIWMB) include the waste building materials, packaging and rubble resulting from construction, remodeling, repair and demolition operations on pavements, houses, commercial buildings and other structures.

“Construction quality assurance” or “CQA” (SWRCB) means a planned system of activities that provides assurance that the facility, or component thereof, is constructed as specified in the approved design. As used in these regulations, the term includes “Construction quality control” or “CQC”, a planned system of inspections that is used to directly monitor and control the quality of a construction project.

“Containment” (SWRCB) means the use of waste management unit characteristics or installed systems and structures to prevent or restrict the release of waste constituents, including waste constituents mobilized as a component of leachate or of landfill gas.
“Discharger” (SWRCB) means any person who discharges waste which could affect the quality of waters of the state, and includes any person who owns a waste management unit (Unit) or who is responsible for the operation of a Unit. When referring to dischargers of hazardous waste, the terms "discharge" and "waste" in this definition have the same meaning as they would have under the definitions for these terms provided in section 66260.10 of Chapter 11 of Division 4.5 of Title 22, CCR, effective July 1, 1991.

"Discrete unit" (CIWMB) means any portion of the disposal area that can be individually described.

"Disposal Area" (CIWMB) means that portion of a disposal site which has received or is receiving solid wastes.

"Dump" (CIWMB) means a disposal site which has waste exposed to the elements, vectors and scavengers.

"Dynamic Conditions" (CIWMB) means under transitory loading conditions, such as during an earthquake.

"EA" (CIWMB) means enforcement agency as defined in PRC §40130.

"Earthquake Magnitude" (CIWMB) means the Richter scale of earthquake magnitude used to express the total energy of an earthquake.

"Electrical conductivity" (SWRCB) means the relative ability of water to conduct electrical current. It depends on the ion concentration of, and can be used to approximate the total filterable residue (total dissolved solids) in, the water.

"Environmental Control System" (CIWMB) means a system to prevent the release of waste constituents from the containment structures of sites. Environmental control system for the purpose of this definition does not include systems which primary function is to protect water quality.

"Excess exposure" (SWRCB) means that, for an organism exposed to a release from a waste management unit, the combined effect of all hazardous constituents in the organism's environment is such that the organism will suffer some measurable adverse effect on health or reproductive success, which effect is partly or wholly attributable to the release.

"Existing" (SWRCB), when describing a waste management unit (e.g., "existing surface impoundment", or "existing Unit"), means that the waste management unit in question was operating, or had received all permits necessary for construction and operation, on or before November 27, 1984, pursuant to §20080(d).

"Existing Footprint" (SWRCB) (as capitalized) means the area of land, at an MSW landfill, that is covered by waste as of the date that landfill became subject to the federal regulations of 40 CFR Part 258, pursuant to §258.1 of that part, as published in the Federal Register of October 1, 1993 (Volume 58, No. 189, pages 51546 and 51547). [Note: see also definitions for "Federal Deadline" and "MSW landfill."]

"Existing MSWLF unit" (CIWMB) means any municipal solid waste landfill unit that is receiving solid waste as of the appropriate dates specified in Section 20060. Waste placement in existing units must be consistent with past operating practices or modified practices to ensure good management.

"External hydrogeologic forces" (SWRCB) means seasonal and other fluctuations in ground water levels, and any other hydraulic condition which could cause a change in the hydraulic stress on a containment structure.

"Facility" — see "waste management facility"

"Facility Boundary" (CIWMB) means the boundary surrounding the entire area on which solid waste facility activities occur and are permitted.

"Facility wastewater" (SWRCB) means all wastewater, from whatever source, produced at a confined animal facility.

"Factor of safety" (SWRCB) means the ratio of forces resisting slope or foundation failure over forces driving slope or foundation failure.

"Federal Deadline" (SWRCB) applies only to an MSW landfill, and means the compliance date applicable to that landfill or portion thereof pursuant to §258.1(e) of the federal MSW regulations (40 CFR 258), as revised in the
Federal Register of October 1, 1993 (Volume 58, No. 189, pages 51546 and 51547). The term does not mean the date an MSW landfill must begin monitoring, in that all waste management units subject to these regulations have been required to monitor since the November 27, 1984 version of these regulations (see §20380 et seq.).

"Fill" (CIWMB) includes compacted solid waste and cover material.

"Flexible membrane liner (FML)" — see "geosynthetic(s)"

"Floodplain" (SWRCB) means the land area which is subject to flooding in any year from any source.

"FML" — see "geosynthetic(s)"

"Foundation Failure" (CIWMB) means the failure of a foundation, soil or rock that serves to support an imposed load, along a surface of weakness.

"Freeboard" (SWRCB) means the vertical distance between the lowest point along the top of a surface impoundment dike, berm, levee, or other similar feature and the surface of the liquid contained therein.

"Free liquid" (SWRCB) means liquid which readily separates from the solid portions of waste under ambient temperature and pressure. Free liquids are not present when a 100 milliliter representative sample of the waste can be completely retained in a standard 400 micron conical paint filter for 5 minutes without loss of any portion of the waste from the bottom of the filter (or an equivalent test approved by the Department of Toxic Substances Control).

"Garbage" (CIWMB) includes all kitchen and table food waste, and animal or vegetable waste that attends or results from the storage, preparation, cooking or handling of food stuffs.

"Geologic materials" (SWRCB) means in place naturally occurring surface and subsurface rock and soil.

"Geologist" (CIWMB) means a person who is engaged in professional geological work under the supervision of registered geologist or registered civil engineer, who is in responsible charge of the work, pursuant to section 7805 of the Business and Professions Code.

"Geomembrane" — see "geosynthetic(s)"

"Geosynthetic(s)" (SWRCB) (n) means flexible materials in planar form manufactured to meet specific engineering purposes. The term includes, but is not limited to: "geomembrane", an essentially impermeable membrane used as a barrier to waste solids and liquids, and synonymous with "synthetic liner" and "flexible membrane liner (FML)"; "geocomposite liner (GCL)"; a manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form; "geotextile" (including "geonet"), any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a constructed project, structure, or system.

"Ground acceleration" (SWRCB) means acceleration of earth particles caused by an earthquake.

"Ground rupture" (SWRCB) means disruption of the ground surface due to natural or man made forces (e.g., faulting, landslides, subsidence).

"Ground water" (SWRCB) for the purpose of the SWRCB-published requirements of this subtitle, means water below the land surface that is at or above atmospheric pressure.

"Grout curtain" (SWRCB) means a subsurface barrier to fluid movement, installed by injecting grout mixtures (such as cement, silicates, synthetic resins, etc.) to fill and seal fractures in rock.

"Hazardous constituent" (SWRCB) means a constituent identified in Appendix VIII to Chapter 11 of Division 4.5 of Title 22, CCR, or an element, chemical compound, or mixture of compounds which is a component of a waste or leachate and which has a physical or chemical property that causes the waste or leachate to be identified as a hazardous waste by the California Department of Toxic Substances Control.

"Hazardous waste" (SWRCB) means any waste which, under Article 1, Chapter 11, Division 4.5 (§66261.3 et seq.) of Title 22 of this code, is required to be managed according to Division 4.5 of Title 22 of this code.

"Head" or "hydraulic head" (SWRCB) means the pressure exerted by fluid on a given area. It is caused by the height of the fluid surface above the area.
"Local Air District" (CIWMB) means the local Air Quality Management District (AQMD) or the local Air Pollution Control District (APCD).

"Local Government" (CIWMB) is a local public entity which is a county, city, district, or any other special political subdivision, but is not the State.

"Manure" (SWRCB) means the accumulated moist animal excrement that does not undergo decomposition or drying as would occur on open grazing land or natural habitat. This definition shall include feces and urine which may be mixed with bedding materials, spilled feed, or soil.

"Maximum credible earthquake", or "MCE" (SWRCB), means the maximum earthquake that appears capable of occurring under the presently known geologic framework. In determining the maximum credible earthquake, little regard is given to its probability of occurrence except that its likelihood of occurring is great enough to be of concern. The term describes an event that could be approached more frequently in one geologic environment than in another; therefore, the following factors have a bearing upon the derivation of the MCE for any given facility:

(a) the seismic history of the vicinity and of the geologic province;
(b) the length of time the fault or faults which can affect the site within a radius of 62 miles (100 kilometers) of the facility boundary;
(c) the type(s) of faults involved;
(d) the tectonic and/or structural history; and
(e) the tectonic and/or structural pattern or regional setting (geologic framework); nevertheless
(f) the time factor shall not be a parameter.

"Maximum probable earthquake", or "MPE" (SWRCB), means the maximum earthquake that is likely to occur during a 100 year interval. The term describes a probable occurrence, rather than an assured event that will occur at a specific time; therefore, the following factors have a bearing upon the derivation of the MPE for a given facility:

(a) the regional seismicity, considering the known past seismic activity;
(b) the fault or faults within a 62 mile (100 kilometer) radius from the facility boundary that may be active within the 100 years following first acceptance of waste;
(c) the type(s) of faults considered;
(d) the seismic recurrence factor for the area described in .(b), above, and for any faults (when known) within that area; and
(e) the mathematic probability analysis (or statistical analysis) of seismic activity associated with the faults included in the area described under .(b), above, including a graphical plot of recurrence information.

Nevertheless, the postulated magnitude of the MPE is superseded by any more powerful seismic event that has occurred within historic time in the area described under .(b), above.

"Measurably significant" (SWRCB) means a change in the Monitoring Point data that, relative to the reference background value (or other approved reference value or distribution), is sufficient to indicate that a release has occurred, pursuant to the applicable data analysis method (including its corresponding trigger).

"Medical Waste" (CIWMB) means waste regulated pursuant to the Medical Waste Management Act, Part 14 (commencing with Section 117600) of Division 104 of the Health and Safety Code.

"Mining waste" (SWRCB) means all waste materials (solid, semi solid, and liquid) from the mining and processing of ores and minerals including soil, waste rock, and other forms of overburden as well as tailings, slag, and other processed mining wastes.

"Moisture holding capacity" (SWRCB) means the amount of liquid which can be held against gravity by waste materials without generating free liquid.

"Monitoring parameter" (SWRCB) means one of the set of parameters specified in the waste discharge requirements for which monitoring is conducted. Monitoring parameters include physical parameters, waste constituents, reaction products, and hazardous constituents, that provide a reliable indication of a release from a waste management unit.
"Monitoring Point" (SWRCB) (as capitalized) means a well, device, or location specified in the waste discharge requirements at which monitoring is conducted and at which the water quality protection standard, under §20390, applies.

"MSW landfill" or "municipal solid waste landfill unit" (SWRCB) means any landfill that is subject to the federal regulations of 40CFR258, including any portion of a disposal site that is subject to those regulations. The term includes any landfill, other than a Class I landfill, that received municipal solid waste (MSW) at any time and that has received any solid waste since October 9, 1991; therefore, the term does not include any landfill that stopped receiving waste prior to that date.

"Municipal solid waste," or "MSW" (SWRCB) has the same meaning as under 40 CFR Part 258.

"New Unit" (SWRCB), when applied to a waste management unit (Unit) or portion thereof, means that the Unit (or portion thereof) began operating, or had received all permits necessary for construction and operation, after November 27, 1984, pursuant to §20080(d).

"New MSWLF unit" (CIWMB) means any municipal solid waste landfill unit that has not received waste prior to the operative date of October 9, 1993, or prior to October 9, 1997 if the MSWLF unit meets the conditions of 40 CFR 258.1(f)(1).

"Nonhazardous solid waste" (SWRCB) has the same meaning as under §20220(a).

"Nuisance" (SWRCB) has the same meaning as under Water Code §13050(m).

"Nuisance" (CIWMB) for CIWMB-promulgated sections includes anything which is injurious to human health or is indecent or offensive to the senses and interferes with the comfortable enjoyment of life or property, and affects at the same time an entire community, neighborhood, household or any considerable number of persons although the extent of annoyance or damage inflicted upon an individual may be unequal and which occurs as a result of the storage, removal, transport, processing or disposal of solid waste.

"On-site" (CIWMB) means located within the permitted boundary.

"Open burning" (CIWMB) means the combustion of solid waste without:
1. Control of combustion air to maintain adequate temperature for efficient combustion,
2. Containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and
3. Control of the emission of the combustion products.

"Operating" (CIWMB) means currently active or the period of site activity from the first receipt of waste until the final receipt of waste consistent with the normal pattern of operation in the solid waste facility permit.

"Operating" (SWRCB) — see “active life”

"Operating Area" (CIWMB) means that portion of a solid waste facility which is currently in use for the unloading, management or disposal of wastes.

"Operating life" — see “active life”

"Operator" (CIWMB) means the landowner or other person who through a lease, franchise agreement or other arrangement with the landowner becomes legally responsible to the State for including, but not limited to, the following requirements for a solid waste facility or disposal site:
(A) obtaining a solid waste facility permit;
(B) complying with all applicable federal, state and local requirements;
(C) the physical operation of the facility or site; and
(D) closing and maintaining the site during the postclosure maintenance period.

"Overpulling" (CIWMB) means excessive air intrusion into a disposal site during gas extraction to control the migration of landfill gas or to increase the production of landfill gas in an energy production system or flare.

"Partial Final Closure" (CIWMB) means the closure of discrete units of a site consistent with the approved closure and postclosure maintenance plan.
"Peak stream flow" (SWRCB) means the maximum expected flow of surface water at a waste management facility from a tributary watershed for a given recurrence interval.

"Peer-reviewed" (CIWMB) means published and independently reviewed by other experts within the same academic field.

"Perched ground water" (SWRCB) means a body of unconfined ground water separated from the zone of saturation by a portion of the unsaturated zone. Such perched water can be either permanent or ephemeral.

"Permeability" (SWRCB) means the ability of natural and artificial materials to transmit fluid.

"Physical parameter" (SWRCB) means any measurable physical characteristic of a substance including, but not limited to, temperature, electrical conductivity, pH, and specific gravity.

"Point of Compliance" (SWRCB) (as capitalized) means a vertical surface located at the hydraulically downgradient limit of a waste management unit (Unit) and that extends through the uppermost aquifer underlying the Unit.

"Post closure maintenance" (SWRCB) means all activities undertaken at a closed waste management unit to maintain the integrity of containment features and to monitor compliance with applicable performance standards.

"Post closure maintenance period" (SWRCB) means the period after closure of a waste management unit (Unit) during which the waste in the Unit could have an adverse effect on the quality of the waters of the state.

"Premises" (CIWMB) includes a tract or parcel of land with or without habitable buildings or appurtenant structures.

"Principal Gases" (CIWMB) means the organic or inorganic constituents of landfill gas, greater than one percent by volume, that typically include carbon dioxide, methane, oxygen, and nitrogen.

"Private Access" (CIWMB) means that public access and disposal are not allowed.

"Probable maximum precipitation" (SWRCB) means the estimated amount of precipitation for a given duration, drainage area, and time of year, which approaches and approximates the maximum that is physically possible within the limits of contemporary hydrometeorological knowledge and techniques. The term describes a precipitation event that has virtually no risk of being exceeded.

"Professional Land Surveyor" (CIWMB) means a land surveyor licensed by the State of California pursuant to section 8747 of the Business and Professions Code.

"Putrescible Wastes" (CIWMB) include wastes that are capable of being decomposed by microorganisms with sufficient rapidity as to cause nuisances because of odors, gases or other offensive conditions.

"P value" (SWRCB) means the smallest significance level for which the null hypothesis would be rejected, based on the data that was actually observed.

"Rapid geologic change" (SWRCB) means alteration of the ground surface through such actions as landslides, subsidence, liquefaction, and faulting.

"R Chart (range chart)" (SWRCB) means a control chart for evaluating the variability within a process in terms of the subgroup range R.

"Reconstruction" (SWRCB) means modification to an existing waste management unit (Unit) which entails costs amounting to 50 percent or more of the initial cost of the Unit.

"Refuse" (CIWMB) includes garbage and rubbish.

"Regional Water Quality Control Board" — see "RWQCB"

"Registered Civil Engineer" (CIWMB) means a civil engineer registered by the State of California, pursuant to section 6762 of the Business and Professions Code.

"Registered Geologist" (CIWMB) means a geologist registered by the State of California, pursuant to section 7842 of the Business and Professions Code.
“Regulated Hazardous Waste” (CIWMB) means a hazardous waste, as defined in §66260.10 of Division 4.5 of Title 22 of this code.

“Relative compaction” (SWRCB) means the degree of compaction achieved, as a percentage of the laboratory compaction, in accordance with accepted civil engineering practices.

“Removal” (CIWMB) means the act of taking solid wastes from the place of waste generation either by an approved collection agent or by a person in control of the premises.

“Removal Frequency” (CIWMB) means frequency of removal of solid wastes from the place of waste generation either by an approved collection agency or by the owner of the waste, or frequency of removal of recyclables at facilities which separate recyclables from the waste stream.

“Rubbish” (CIWMB) includes non putrescible solid wastes such as ashes, paper, cardboard, tin cans, wood, glass, bedding, crockery, plastics, rubber by products or litter.

“Run-off” (SWRCB) means any precipitation, leachate, or other liquid that drains from any part of a waste management unit (Unit).

“Run-on” (SWRCB) means any precipitation or other liquid that drains onto any part of a waste management unit.

“RWQCB” or “Regional Water Quality Control Board” (RWQCB) has the same meaning as does the latter term, as described under Division 7 of the California Water Code.

“RWQCB-Permitted Area” (SWRCB) (as capitalized) means the portion of land designated in WDRs for the discharge of waste at a waste management unit.

“Salvaging” (CIWMB) means the controlled removal of waste materials for utilization.

“Saturated zone” (SWRCB) means an underground zone in which all openings in and between natural geologic materials are filled with water.

“Seavenging” (CIWMB) means the uncontrolled and/or unauthorized removal of solid waste materials, or recyclable material at a solid waste facility.

“Semi solid waste” (SWRCB) means waste containing less than 50 percent solids.

“Sensitive biological receptor of concern” (SWRCB) means a member of any species of organism whose members are likely to be exposed to a release from a waste management unit and experience some measurable adverse effect as a result of that exposure.

“Septic Tank Pumpings” (CIWMB) include sludge and wastewater removed from septic tanks.

“Shredding” (CIWMB) includes a process of reducing the particle size of solid wastes through use of grinding, shredding, milling or rasping machines. Shredding for the purposes of this Division does not apply to shredding of waste tires.

“Site Specific” (CIWMB) means specific to the local site.

“Slope Failure” (SWRCB) means the downward and outward movement of ground slopes (e.g., natural rock, soils, artificial fills, or continuations of these materials).

“Sludge” (SWRCB) means residual solids and semi solids from the treatment of water, wastewater, and other liquids. It does not include liquid effluent discharged from such treatment processes.

“Soil Engineer” (CIWMB) is synonymous with geotechnical engineer; means a registered civil engineer that is qualified to use the title of “soil engineer,” pursuant to California Code of Regulations, Title 16, section 426.50.

“Soil pore liquid” (SWRCB) means the liquid contained in openings between particles of soil in the unsaturated zone.

“Solid Waste Management” (CIWMB) includes a planned program for effectively controlling the generation, storage, collection, transportation, processing and reuse, conversion or disposal of solid wastes in a safe, sanitary,
aesthetically acceptable, environmentally sound and economical manner. It includes all administrative, financial, environmental, legal and planning functions as well as the operational aspects of solid waste handling, disposal and resource recovery systems necessary to achieve established objectives.

"Sorbent" (SWRCB) means a substance which takes up and holds a liquid either by absorption or adsorption.

"Special Waste" (CIWMB) means "special waste" as defined in Title 22.

"State Minimum Standards" (CIWMB) means the following sections of this Division for the purposes of implementing Public Resources Code Section 44104: 20510 to 20701, 20710 to 20937, 21100 to 21200, 21430 and 21600.

"State Water Resources Control Board" — see "SWRCB"

"Static Conditions" (SWRCB) means under conditions of no external motions or forces, such as those of earthquakes.

"Statistically significant" (SWRCB) means a statistical test has a p value that is small enough for the null hypothesis to be rejected.

"Storage" (SWRCB) means the holding of waste or recyclable materials for a temporary period, at the end of which the materials either is treated or is discharged elsewhere.

"Store" (CIWMB) means stockpile, accumulate for later use or discard. [Note: this standard does not apply to waste tires.]

"Storm" (SWRCB) means the maximum precipitation for a given duration that is expected during the given recurrence interval [e.g., a 24-hour (duration) 100 year (recurrence interval) storm].

"Surface Impoundment" (SWRCB) means a waste management unit which is a natural topographic depression, excavation, or diked area, which is designed to contain liquid wastes or wastes containing free liquids, and which is not an injection well.

"SWRCB" (SWRCB) means the State Water Resources Control Board, as described under Division 7 of the Water Code.

"Synthetic liner" — see "geosynthetic(s)"

"Tailings pond" (SWRCB) means an excavated or diked area which is intended to contain liquid and solid wastes from mining and milling operations.

"Trace Gases" (CIWMB) means all other organic or inorganic compounds or elements, measured at less than one percent by volume, found together with the principal gases in landfill gas, and may include vinyl chloride, benzene, hydrogen sulfide, carbon monoxide, hydrogen, mercury, etc.

"Transmissivity" (SWRCB) means the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

"Treatment" (SWRCB) means any method, technique, or process designed to change the physical, chemical, or biological characteristics of waste so as to render it less harmful to the quality of the waters of the state, safer to handle, or easier to contain or manage. The term includes use of waste as a fuel, nutrient, or soil amendment.

"Treatment zone" (SWRCB) means a soil area of the unsaturated zone of a land treatment unit within which constituents of concern are degraded, transformed, or immobilized.

"Underlying ground water" (SWRCB), for the purposes of waste management unit siting criteria, includes water which rises above the zone of saturation due to capillary forces.

"Unit" — see "waste management unit"

" Unsaturated zone" (SWRCB) means the zone between the ground surface and the regional water table or, in cases where the uppermost aquifer is confined, the zone between the ground surface and the top of the saturated portion of the aquifer’s confining layer.
"Unstable Areas" (CIWMB) means locations susceptible to natural or human induced events or forces which are capable of rupturing the site containment structure.

"Uppermost aquifer" (SWRCB) means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer.

"Vector" (CIWMB) includes any insect or other arthropod, rodent, or other animal capable of transmitting the causative agents of human disease, or disrupting the normal enjoyment of life by adversely affecting the public health and well being.

"Waste constituent" (SWRCB) means a constituent that is reasonably expected to be in or derived from waste contained in a waste management unit.

"Waste management facility" or "facility" (SWRCB) means the entire parcel of property at which waste discharge operations are conducted. Such a facility may include one or more waste management units.

"Waste management unit" or "Unit" (SWRCB) (the latter capitalized or in quotes at the beginning of a sentence) means an area of land, or a portion of a waste management facility, at which waste is discharged. The term includes containment features and ancillary features for precipitation and drainage control and for monitoring.

"Waste pile" (SWRCB) means a waste management unit (Unit) at which only noncontainerized, bulk, dry solid waste is discharged and piled for treatment or storage on an engineered liner system that prevents the waste from contacting the underlying land surface. The term does not include a Unit of similar construction which is used for waste disposal (such as a Unit would be a landfill).

"Water quality impairment" (SWRCB) means degradation of the existing quality of a body of surface or ground water resulting from a release of waste constituents, waste-derived hazardous constituents, or reaction products, including but not limited to any incomplete decomposition product which could cause nuisance by odor.

"Water Standard" (SWRCB) (as capitalized) means the water quality protection standard under §20390.

"WDRs" (SWRCB) means waste discharge requirements.

"X Bar chart" (SWRCB) means a control chart for evaluating the process level or subgroup differences in terms of the subgroup average.

"Zone of saturation" (SWRCB) means the subsurface zone which extends downward from the base of the unsaturated zone in which the interstices are filled with water under pressure that is equal to or greater than atmospheric pressure. Although the zone can contain gas filled interstices (in which the gas pressure exceeds atmospheric pressure) or interstices filled with fluids other than water, it is still considered saturated.


Authority cited: Section 40502 Public Resources Code, Reference: Sections 40000, 40001, 40002, and 43103 and Title 40, CFR 258.2.

Chapter 3. Criteria for All Waste Management Units, Facilities, and Disposal Sites
Subchapter 1. General
Article 1. CIWMB - General

20180. CIWMB - Owner and Operator. (T14-§17602)

Responsibility for compliance with the standards in this chapter shall rest with both the owner and the operator. If specifically designated, the operator is considered to have prime responsibility for compliance; however, this does not relieve the owner of the duty to take all reasonable steps to assure compliance with these standards and any assigned conditions.
Chapter 2. Siting and Design

1. [Reserved by SWRCB]

2. SWRCB - Waste Classification and Management

10. SWRCB - Applicability and Classification Criteria. (C15: §2520)

Concept—This article contains a waste classification system which applies to solid wastes that cannot be
handled directly or indirectly to waters of the state and which therefore must be discharged to waste
treatment units (Units) for treatment, storage, or disposal in accordance with the requirements of this
division.

which can be discharged directly or indirectly (e.g., by percolation) to waters of the state under effluent
or treatment limits that implement applicable water quality control plans (e.g., municipal or industrial effluent or
wastewater) are not subject to the SWRCB-promulgated provisions of this division. This waste
classification system shall provide the basis for determining which wastes may be discharged at each class of Unit.
Classification is based on an assessment of the potential risk of water quality degradation associated with
certain of the waste.

The waste classifications in this article shall determine where the waste can be discharged unless the waste
does not consist of or contain municipal solid waste (MSW) and the discharger establishes to the satisfaction of the
Division that a particular waste constituent or combination of constituents presents a lower risk of water quality
degradation than indicated by classification according to this article.

2. Discharges of wastes identified in §20210 or §20220 of this article shall be permitted only at Units which
have been approved and classified by the RWQCB in accordance with the criteria established in Article 3 of
Chapter, and for which WDRs have been prescribed or waived pursuant to Article 4, Subchapter 3, Chapter 4 of
Division (§21710 et seq.). Table 2.1 (of this article) presents a summary of discharge options for each waste
category.

3. Dedicated Units/Cells For Certain Wastes—The following wastes shall be discharged only at dedicated
[or dedicated landfill cells (e.g., ash monofill cell)] which are designed and constructed to contain such
wastes:

(a) wastes which cause corrosion or decay, or otherwise reduce or impair the integrity of containment
structures;

(b) wastes which, if mixed or commingled with other wastes can produce a violent reaction (including heat,
secure, fire or explosion), can produce toxic byproducts, or can produce any reaction product(s) which:

(i) requires a higher level of containment;

(ii) is a restricted waste; or

(iii) impairs the integrity of containment structures.

Waste Characterization—Dischargers shall be responsible for accurate characterization of wastes,
including determinations of whether or not wastes will be compatible with containment features and other wastes
in a Unit under §4.3, and whether or not wastes are required to be managed as hazardous wastes under Chapter 11
Division 4.5 of Title 22 of this code.

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this article, on field inspections by RWQCB and SWRCB staffs, and on other pertinent information. Information used to classify Units shall be submitted according to the provisions of Article 4, Subchapter 3, Chapter 4 of this subdivision (§21710 et seq.). Owners or operators of classified Units shall comply with waste discharge requirements (WDRs) adopted by the RWQCB.

(b) Reclassification—Existing Units shall be reclassified according to applicable criteria in this article, provided that such Units:

(1) comply with siting criteria for each category of existing Units in §20250 and §20260, and summarized in Table 3.1 of this article; and

(2) are operating in compliance with §20080(d).

c) Five-Foot Separation — All new landfills, waste piles, and surface impoundments shall be sited, designed, constructed, and operated to ensure that wastes will be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water. Existing landfills, waste piles, and surface impoundments shall be operated to ensure that wastes will be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water. For new and existing land treatment units, the base of the treatment zone shall be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water and dischargers shall not be entitled to exemption under §20080(b).

d) Unit Foundation — All engineered structures (including, but not limited to, containment structures) constituting any portion of a Unit shall have a foundation or base capable of providing support for the structures, and capable of withstanding hydraulic pressure gradients to prevent failure due to settlement, compression, or uplift and all effects of ground motions resulting from a minimum probable earthquake (for Class III Units (see §20370)) or the maximum credible earthquake (for Class II Units (see §20370)), as certified by a registered civil engineer or certified engineering geologist. [Note: see also §21730(3)(5).] NOTE: Authority cited: Section 1058, Water Code. Reference: Sections 13072 and 13360, Water Code; Section 43103, Public Resources Code.

20250. SWRCB - Class II: Waste Management Units for Designated Waste. (C15: §2532)

(a) General — Class II waste management units (Class II Units) shall be located where site characteristics and containment structures isolate waste from waters of the state. The classification criteria in this section shall be used for reclassification of existing Units at disposal sites approved as Class II under previous versions of these SWRCB regulations, and for existing Units used for treatment or for storage, whether or not classified, provided that no hazardous wastes other than those which DTSC has determined need not be discharged as a hazardous waste have been discharged at such Units (including discharge at any expansion of such Units).

(b) Geologic Setting.

(1) New and existing Class II landfills or waste piles shall be immediately underlain by natural geologic materials which have a hydraulic conductivity of not more than 1x10^-6 cm/sec (i.e., 1 foot/year) and which are of sufficient thickness to prevent vertical movement of fluid, including waste and leachate, from Units to waters of the state for as long as wastes in such units pose a threat to water quality. Class II units shall not be located where areas of primary (porous) or secondary (rock opening) hydraulic conductivity greater than 1x10^-6 cm/sec (i.e., 1 foot/year) could impair the competence of natural geologic materials to act as a barrier to vertical fluid movement.

(2) Natural or artificial barriers shall be used to prevent lateral movement of fluid, including waste and leachate.

(3) A liner system which conforms to the requirements of Article 4 of this subchapter with a hydraulic conductivity of not more than 1x10^-6 cm/sec (i.e., 1 foot/year) shall be used for landfills and waste piles when natural geologic materials do not satisfy the requirements in .(b)(1).

(4) Class II surface impoundments are not required to comply with the requirements of .(b)(1), but shall have a liner system designed in accordance with the applicable SWRCB-promulgated provisions of Article 4 of this subchapter (§20310 et seq.). The RWQCB can allow Class II surface impoundments which are designed and
constructed with a double liner system in accordance with that article to use natural geologic materials which comply with (b)(1) for the outer liner.

(5) Land treatment units (LTUs) are not required to comply with the requirements of (b). Dischargers who treat or dispose of wastes in LTUs shall demonstrate, prior to application of the waste, that waste can be completely degraded, transformed, or immobilized in the treatment zone. To demonstrate this, prior to the application of waste, the discharger shall operate a test plot for a sufficient period to give the RWQCB a reasonable indication that degradation, transformation, or immobilization will take place in the treatment zone. During the full scale operation of the LTU, soil and soil pore liquid samples shall be taken within the treatment zone to verify that complete degradation, transformation, or immobilization is taking place. The RWQCB shall specify in WDRs the elements of the land treatment program including the dimensions of the treatment zone. The maximum depth of the treatment zone shall not exceed 5 feet from the initial soil surface.

(c) Flooding — New and existing Class II Units shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100 year return period. MSW landfills are also subject to any more-stringent flood plain and wetland siting requirements referenced in SWRCB Resolution No. 93-62 (i.e., see §258.11 and §258.12 of 40CFR258).

(d) Ground Rupture — New Class II Units, other than LTUs and expansions of existing Class II units, shall have a 200 foot setback from any known Holocene fault. Other units (that are subject to this section) can be located within 200 feet of a known Holocene fault, provided the RWQCB finds that the Unit’s containment structures are capable of withstanding ground accelerations associated with the maximum credible earthquake.

(e) Rapid Geologic Change — New and existing Class II Units can be located within areas of potential rapid geologic change only if the RWQCB finds that the Unit’s containment structures are designed, constructed, and maintained to preclude containment failure. MSW landfills are also subject to any more-stringent unstable area siting requirements referenced in SWRCB Resolution No. 93-62 (i.e., see §258.15 and §258.16 of 40CFR258).

(f) Tidal Waves — New and existing Class II Units may be located in areas subject to tsunamis, seiches, and surges. Other Units may be located within these areas if designed, constructed, and maintained to preclude failure due to such events.


.20260. SWRCB - Class III: Landfills for Nonhazardous Solid Waste. (C15: §2533)

(a) General — Class III landfills shall be located where site characteristics provide adequate separation between nonhazardous solid waste and waters of the state. The classification criteria in this section shall be used for reclassification of existing landfills at disposal sites approved as Class II-1 or II-2 (under previous versions of these SWRCB regulations) and any expansions of such landfills.

(b) Geologic Setting.

(1) MSW landfills are subject to the SWRCB-promulgated waste containment requirements of this subdivision and of SWRCB Resolution No. 93-62. New Class III and existing Class II-2 landfills shall be sited where soil characteristics, distance from waste to ground water, and other factors will ensure no impairment of beneficial uses of surface water or of ground water beneath or adjacent to the landfill. Factors that shall be evaluated include:

(A) size of the landfill;

(B) hydraulic conductivity and transmissivity of underlying soils;

(C) depth to ground water and variations in depth to ground water;

(D) background quality of ground water;

(E) current and anticipated use of the ground water; and

(F) annual precipitation.
(2) Where consideration of the factors in (b)(1) indicates that site characteristics alone do not ensure protection of the quality of ground water or surface water, Class III landfills shall be required to have a single clay liner with hydraulic conductivity of 1 x 10^-6 cm/sec or less.

(c) Flooding — New Class III and existing Class II-2 landfills shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100 year return period. MSW landfills are also subject to any more-stringent flood plain and wetland siting requirements referenced in SWRCB Resolution No. 93-62 (i.e., see §§258.11, 258.12, and 258.16 of 40CFR258).

(d) Ground Rupture — New Class III and expansions of existing Class II-2 landfills shall not be located on a known Holocene fault. However, existing landfills assigned a Class II-2 designation under previous versions of the SWRCB regulations may be located on a known Holocene fault, provided that the Unit's containment structures are capable of withstanding ground accelerations associated with the maximum probable earthquake (see §20370).

(e) Rapid Geologic Change — New Class III and unreclassified existing Class II-2 landfills can be located within areas of potential rapid geologic change only if the RWQCB finds that the Unit's containment structures are designed, constructed, and maintained to preclude failure. MSW landfills are also subject to any more-stringent unstable area siting requirements referenced in SWRCB Resolution No. 93-62 (see §§258.15 and §258.16 of 40CFR258).


.20270. CIWMB - Location Restrictions: Airport Safety. (T14;§17258.10)

(a) Owners or operators of new Municipal Solid Waste Landfill units (MSWLF), existing MSWLF units, and lateral expansions of MSWLF units that are located within 10,000 feet (3,048 meters) of any airport runway end used by turbojet aircraft or within 5,000 feet (1,524 meters) of any airport runway end used by only piston-type aircraft must demonstrate that the units are designed and operated so that the MSWLF unit does not pose a bird hazard to aircraft.

(b) Owners or operators proposing to site new MSWLF units and lateral expansions located within a five-mile radius of any airport runway end used by turbojet or piston-type aircraft must notify the affected airport and the Federal Aviation Administration (FAA).

(c) The owner or operator must place the demonstration made pursuant to paragraph (a) of this section in the operating record and notify the EA that it has been placed in the operating record.

(d) Existing MSWLF units that cannot make the demonstration specified in §20270(a) pertaining to airports must:

1. close by October 9, 1996, in accordance with §21110 of this article;
2. conduct postclosure activities in accordance with §21110 of this article; and
3. conduct closure and postclosure activities in accordance with applicable sections of Chapter 4, and Chapter 6, of this Division.

(e) The deadline for closure required by paragraph (a) of this section may be extended up to two years if the owner or operator demonstrates to the CIWMB that:

1. There is no available alternative disposal capacity; and
2. There is no immediate threat to human health and the environment.

Note: Authority cited: Section 40502, 43020, 43021 Public Resources Code. Reference: Section 40508 and 43103, Public Resources Code; and Title 40, Code of Federal Regulations, Section 258.10, and 258.16.
Article 4. SWRCB - Waste Management Unit Construction Standards

20310. SWRCB - General Construction Criteria. (C15: §2540)

(a) Class II waste management units (Class II “Units”) shall be designed and constructed to prevent migration of wastes from the Units to adjacent geologic materials, ground water, or surface water, during disposal operations, closure, and the post closure maintenance period. Class II and Class III MSW landfills are also subject to any applicable waste containment system design requirements of SWRCB Resolution No. 93-62 to the extent that such requirements are more stringent than those applicable to a non-MSW Class II or Class III landfill under this subdivision.

(b) Each Class II Unit shall be designed and constructed for the containment of the specific wastes which will be discharged.

(c) Class III landfills shall have containment structures which are capable of preventing degradation of waters of the state as a result of waste discharges to the landfills if site characteristics are inadequate.

(d) For the purposes of this paragraph, the words “new” and “existing” have the same meaning as described in §20080(d). New landfills, waste piles, and surface impoundments shall comply with the requirements of this article. Existing waste piles and surface impoundments shall be fitted with liners and leachate collection and removal systems as described in §20330 and §20340 as feasible. Existing landfills and waste piles shall have interim cover as described in §20705. Existing landfills, waste piles, and surface impoundments shall be fitted with subsurface barriers as described in §20360 as needed and feasible, and shall have precipitation and drainage control facilities as described in §20365. Existing surface impoundments shall comply with §20375. New and existing land treatment units shall comply with §20377. All existing Units shall comply with the seismic design criteria in Section 20370.

(e) Containment structures shall be designed by, and construction shall be supervised and certified by, a registered civil engineer or a certified engineering geologist. Units shall receive a final inspection and approval of the construction by RWQCB or SWRCB staff before use of the Unit commences.

(f) The discharger shall maintain the integrity of containment structures in spite of normal excavation or fire control work; nevertheless, for fire control work, the discharger can damage containment structures to the extent necessary to control the fire, so long as the discharger promptly repairs such damage after extinguishing the fire. Excavations made as part of discharge operations shall not result in removal of any portion of a containment structure.

(g) Stability Analysis — For any portions of the Unit’s containment system installed after July 18, 1997, for which the RWQCB has not approved a slope and foundation stability report on or before that date, the discharger shall meet the requirements of §21750(c)(3).

### TABLE 3.1 SWRCB's GEOLOGIC AND SITING CRITERIA FOR CLASSIFIED UNITS — Unit Classification

<table>
<thead>
<tr>
<th>Site Characteristics</th>
<th>[Reserved]^1</th>
<th>New Class II^1</th>
<th>Reclassification of Existing Class II</th>
<th>New Class III^1</th>
<th>Reclassification of Existing Class II-2^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geologic Setting</td>
<td>Substantial isolation from groundwater, see §20250(b)</td>
<td>As for new Class II</td>
<td>Adequate separation from groundwater; characteristics other than hydraulic conductivity will be considered; see §20260(b)</td>
<td>As for new Class III</td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td>&lt;&lt;-----------</td>
<td>No Siting Restriction^1</td>
<td>&lt;&lt;-------------------------------</td>
<td>&lt;&lt;------------------</td>
<td></td>
</tr>
<tr>
<td>Ground Rupture</td>
<td>200' setback from known Holocene fault</td>
<td>Exempt^1, except that expansions are as for new Class II</td>
<td>Not located on known Holocene fault</td>
<td>Exempt^1, except that expansion as new Class III</td>
<td></td>
</tr>
<tr>
<td>Rapid Geologic Change</td>
<td>&lt;&lt;-----------</td>
<td>No Siting Restriction^1</td>
<td>&lt;&lt;-------------------------------</td>
<td>&lt;&lt;------------------</td>
<td></td>
</tr>
<tr>
<td>Tidal Waves</td>
<td>&lt;&lt;-----------</td>
<td>No Siting Restriction^1</td>
<td>&lt;&lt;-------------------------------</td>
<td>&lt;&lt;------------------</td>
<td></td>
</tr>
</tbody>
</table>

1 [Reserved.] Note: These standards removed because they apply only to Class I Units (see Chapter 15, Div. 3., Title 23, CCR).
2 This category is defined in §20250(a).
3 This category is defined in §20260(a).
4 [Reserved.] Note: Left in Ch-15. Applies only to Class I Units.
5 Exemption from siting criteria does not release dischargers from the obligation to protect Units from the geologic or environmental hazards involved. Exemption is conditioned on such protection.
6 The term “Tidal Waves” includes tsunamis, seiches, and surge condition.
<table>
<thead>
<tr>
<th>Waste Mgmt Unit Classification</th>
<th>Type of Waste Management Unit</th>
<th>Clay Liner</th>
<th>Synthetic Liner</th>
<th>Leachate Collection and Rem. System</th>
<th>Interim Cover</th>
<th>Subsurface Barriers</th>
<th>Capacity of Precip. &amp; Drain. Control Facilities (Design Storm)</th>
<th>Seismic Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class II</td>
<td>Non MSW Landfill</td>
<td>Required, 1x10⁻⁶ cm/sec</td>
<td>Not required</td>
<td>Required, blanket type</td>
<td>Required</td>
<td>1x10⁻⁶ cm/sec</td>
<td>10-year 24-hour precipitation</td>
<td>Withstand maximum credible earthquake</td>
</tr>
<tr>
<td>Class II</td>
<td>MSW Landfill</td>
<td>Special</td>
<td>Special</td>
<td>Special</td>
<td>Required</td>
<td>1x10⁻⁶ cm/sec</td>
<td>1000-year 24-hour precipitation</td>
<td>Withstand maximum credible earthquake</td>
</tr>
<tr>
<td>Class II</td>
<td>Surface Impoundment</td>
<td>Double or single required, 1x10⁻⁶ cm/sec</td>
<td>Not required</td>
<td>Required with double liner, blanket type</td>
<td>Not Required</td>
<td>1x10⁻⁶ cm/sec</td>
<td>1000-year 24-hour precipitation</td>
<td>Withstand maximum credible earthquake</td>
</tr>
<tr>
<td>Class II</td>
<td>Waste Pile</td>
<td>Optional, 1x10⁻⁶ cm/sec</td>
<td>Not required</td>
<td>May be required, blanket type</td>
<td>May be required</td>
<td>1x10⁻⁶ cm/sec</td>
<td>1000-year 24-hour precipitation</td>
<td>Withstand maximum credible earthquake</td>
</tr>
<tr>
<td>Class III</td>
<td>Non MSW Landfill</td>
<td>Optional, 1x10⁻⁶ cm/sec (see §20360)</td>
<td>Not required</td>
<td>Required if liner is required, blanket or densistic</td>
<td>Required</td>
<td>1x10⁻⁶ cm/sec, if required</td>
<td>100-year, 24-hour precipitation (§20370)</td>
<td>Withstand at least the maximum probable earthquake (see §20370)</td>
</tr>
<tr>
<td>Class III</td>
<td>MSW Landfill</td>
<td>Special</td>
<td>Special</td>
<td>Special</td>
<td>Required</td>
<td>1x10⁻⁶ cm/sec, if required</td>
<td>100-year, 24-hour precipitation (§20370)</td>
<td>Withstand at least the maximum probable earthquake (see §20370)</td>
</tr>
</tbody>
</table>

Note: This footnote left in Ch-13 of Division 3, Title 25, CCR, as it applies only to Class I Units.

1. Applicable regulations in this article may provide for exemptions to certain requirements. §20310(d) describes applicability to existing facilities.

2. All permeabilities specified in this table are maximum allowable permeabilities.

3. A synthetic liner alone may be allowed based on nature of waste to be contained and duration of the operation. A waste pile with a synthetic liner alone may not be closed as a landfill pursuant to §21410 of this subchapter.

4. Clay liner required unless units are underway by a substantial thickness of natural geologic materials with hydraulic conductivity of 1x10⁻⁶ cm/sec [i.e., 1 foot/year] or less.

5. Double liner systems shall have either an outer clay liner or shall be undertaken by a substantial thickness of natural geologic materials with an hydraulic conductivity of 1x10⁻⁶ cm/sec [i.e., 1 foot/year] or less to act as an outer liner.

6. If less than 100 feet from a public water supply, all landfill leachate collection systems shall be designed to exclude any potential leachate from entering the water supply.
Figure 4.1:
SUMMARY OF LINER REQUIREMENTS FOR
CLASSIFIED WASTE MANAGEMENT UNIT

(Footnotes on back of page)

NOTE: all figures are shown at the end of this file.
FOOTNOTES FOR FIGURE 4.1: SUMMARY OF LINER REQUIREMENTS
FOR CLASSIFIED UNITS (FOR MSW LANDFILLS, SEE ADDITIONAL
REQUIREMENTS IN SWRCB RESOLUTION NO. 93-62).

a. Requirements from Chapter 3, Subdivision 1 of this division.
b. Designed to convey twice the anticipated volume of leachate; must ensure no buildup of hydraulic head on liner;
   blanket type required unless otherwise specified.
c. Minimum 40 mils thick.
d. Must be compatible with waste and/or leachate.
e. Cutoff walls required where potential exists for lateral movement of waste or leachate.
f. Acceptability of synthetic liner depends on nature of waste and duration of operation.
g. Liner and waste to be removed at closure.
h. Substantial thickness of natural geologic material with maximum hydraulic conductivity of 1x10^-6 cm/sec (i.e.,
   1.0 foot/year). For MSW landfills, see SWRCB Resolution No. 93-62 for superseding containment system
   requirements.
i. Minimum thickness of 2 feet; maximum hydraulic conductivity of 1x10^-6 cm/sec (i.e., 1.0 foot/year). For MSW
   landfills, see SWRCB Resolution No. 93-62 for superseding containment system requirements.
j. Liner removed or replaced before lower 25% (minimum 1 foot thickness) of the liner is penetrated by waste or
   leachate.
k. Soil characteristics, distance from waste to ground water, and other factors must ensure no impairment of
   beneficial uses of ground water. Leachate collection system required for sludge disposal. For MSW landfills,
   see SWRCB Resolution No. 93-62 for superseding containment system requirements.
l. Minimum thickness of 1 foot; maximum hydraulic conductivity of 1x10^-6 cm/sec (i.e., 1.0 foot/year). For MSW
   landfills, see SWRCB Resolution No. 93-62 for superseding containment system requirements.
m. Dendritic system allowed if wastes in contact with the liner will remain permeable and liner is sloped toward
   the system to prevent ponding. For MSW landfills, see SWRCB Resolution No. 93-62 for superseding
   containment system requirements.

20320. SWRCB - General Criteria for Containment Structures. (C15: §2541)

(a) Material Properties — Materials used in containment structures shall have appropriate chemical and
    physical properties to ensure that such structures do not fail to contain waste because of pressure gradients
    (including hydraulic head and external hydrogeologic forces), physical contact with the waste or leachate, chemical
    reactions with soil and rock, climatic conditions, the stress of installation, or because of the stress of daily
    operation.

(b) Applicable Permeants — Hydraulic conductivities specified for containment structures other than cover
    shall be relative to the fluids, including waste and leachate, to be contained. Hydraulic conductivities specified for
    final cover shall be relative to water.

(c) Determining Hydraulic Conductivity — Hydraulic conductivities shall be determined primarily by
    appropriate field test methods in accordance with accepted civil engineering practice. The results of laboratory tests
    with both water and leachate, and field tests with water (e.g., on the test pad), shall be compared to evaluate how
    the field permeabilities will be affected by leachate. It is acceptable for the discharger to use appropriate
    compaction tests in conjunction with laboratory hydraulic conductivity tests to determine field permeabilities as
    long as a reasonable number of field hydraulic conductivity tests are also conducted (e.g., a sealed double-ring
    infiltrometer test on the test pad).
(d) Soils Used in Containment Structures — Earthen materials used in containment structures other than cutoff walls and grout curtains shall consist of a mixture of clay and other suitable fine grained soils which have the following characteristics, and which, in combination, can be compacted to attain the required hydraulic conductivity when installed. Liners made of such materials are referred to as “clay liners” in this subchapter.

(1) At least 30 percent of the material, by weight, shall pass a No. 200 U.S. Standard sieve.

(2) The materials shall be fine grained soils with a significant clay content and without organic matter, and which is a clayey sand, clay, sandy or silty clay, or sandy clay under a soil classification system having industry-wide use [e.g., the “SC”, “CL”, or “CH” soil classes under ASTM Designation: A2487-93 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)].

(e) Synopses — Construction standards for waste management units other than land treatment are given on Table 4.1 and in Figure 4.1.


.20323. SWRCB — CQA Plan. (new)

After July 18, 1997, the RWQCB shall require construction for all liner systems and final cover systems to be carried out in accordance with a CQA plan certified by an appropriately registered professional to satisfy the requirements of §20324. If the RWQCB finds that any construction of the liner system or final cover system was undertaken in the absence of a CQA plan that satisfies the requirements of §20324, the RWQCB shall require the discharger to undertake any corrective construction needed to achieve such compliance.


.20324. SWRCB — CQA Requirements. (T14: §17774)

(a) Performance Standard — The construction quality assurance (CQA) program, including all relevant aspects of construction quality control (CQC), shall provide evidence that materials and procedures utilized in the placement of the any containment feature at a waste management unit (Unit) will be tested and monitored to assure the structure is constructed in accordance with the design specifications approved by the RWQCB.

(b) Professional Qualifications.

(1) The design professional who prepares the CQA plan shall be a registered civil engineer or certified engineering geologist; and

(2) The construction quality assurance program shall be supervised by a registered civil engineer or certified engineering geologist who shall be designated the CQA officer.

(c) Reports.

(1) The project’s CQA report shall address the construction requirements, including any vegetation procedures, set forth in the design plan for the containment system. For each specified phase of construction, this report shall include, but not be limited to:

(A) a delineation of the CQA management organization, including the chain of command of the CQA inspectors and contractors;

(B) a detailed description of the level of experience and training for the contractor, the work crew, and CQA inspectors for every major phase of construction in order to ensure that the installation methods and procedures required in the containment system design will be properly implemented.

(C) a description of the CQA testing protocols for preconstruction, construction, and postconstruction which shall include at a minimum:

1. the frequency of inspections by the operator,
2. the sampling and field testing procedures and equipment to be utilized, and the calibration of field testing equipment;

3. the frequency of performance audits determined by the design professional and examined by the CQA officer;

4. the size, method, location and frequency of sampling, sampling procedures for laboratory testing, the soils or geotechnical laboratory to be used, the laboratory procedures to be utilized, the calibration of laboratory equipment and quality assurance and quality control of laboratory procedures;

5. the pass/fail criteria for sampling and testing methods used to achieve containment system design, and

6. a description of the corrective procedures in the event of test failure.

(d) Documentation — Construction quality assurance documentation requirements shall include, at the minimum: reports bearing unique identifying sheet numbers for cross referencing and document control, the date, project name, location, descriptive remarks, the data sheets, inspection activities, and signature of the designated authorities with concurrence of the CQA officer.

(1) The documentation shall include:

(A) Daily Summary Reports — daily recordkeeping, which shall include preparation of a summary report with supporting inspection data sheets, problem identification and corrective measures reports. Daily summary reports shall provide a chronological framework for identifying and recording all other reports. Inspection data sheets shall contain all observations (i.e., notes, charts, sketches, or photographs), and a record of field and/or laboratory tests. Problem identification and corrective measures reports shall include detailed descriptions of materials and workmanship that do not meet a specified design and shall be cross-referenced to specific inspection data sheets where the problem was identified and corrected;

(B) Acceptance Reports — all reports shall be assembled and summarized into Acceptance Reports in order to verify that the materials and construction processes comply with the specified design. This report shall include, at a minimum, inspection summary reports, inspection data sheets, problem identification and corrective measures reports;

(C) Final Documentation — at the completion of the project, the operator shall prepare a Final Documentation which contains all reports submitted concerning the placement of the containment system. This document shall provide evidence that the CQA plan was implemented as proposed and that the construction proceeded in accordance with design criteria, plans, and specifications. The discharger shall submit copies of the Final Documentation report to the RWQCB as prepared by the CQA officer.

(2) Once construction is complete, the document originals shall be stored by the discharger in a manner that will allow for easy access while still protecting them from any damage. All documentation shall be maintained throughout the postclosure maintenance period.

(e) Laboratory Testing Requirements. [Note: the following (ASTM) standards are available from the American Society of Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2929, phone: 610-832-9583.]

(1) Analysis of earth materials shall be performed prior to their incorporation into any containment system component. Representative samples for each layer within the containment system shall be evaluated. The following minimum laboratory testing procedures shall be performed:

(A) ASTM Designation: D 1557 91 [1/91], “Laboratory Compaction Characteristics of Soil Using Modified Effort (2,700 kN·m/m^3)” which is incorporated by reference;

(B) ASTM Designation: D 422 63 (Reapproved) [9/90], “Standard Method for Particle Size Analysis of Soils,” which is incorporated by reference; and

(2) In addition to the tests listed in (e and f), the following minimum laboratory tests shall be performed on low-hydraulic-conductivity layer components constructed from soil:

(A) ASTM Designation: D 4318 93 [11/93], “Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils,” which is incorporated by reference; and

(B) United States Environmental Protection Agency (USEPA) Test Method 9100 [Approved 9-86], “Triaxial-Cell Method with Back Pressure,” which is incorporated by reference.

(f) Field Testing Requirements — The following minimum field test procedure shall be performed for each layer in the containment system: ASTM Designation: D 2488 93 [9/93], Standard Practice for Description and Identification of Soils (Visual Manual Procedure), which is incorporated by reference.

(g) Test Pad Requirements — Before installing the compacted soil barrier layer component of a final cover system, or the compacted soil component of a liner system, the operator shall accurately establish the correlation between the design hydraulic conductivity and the density at which that conductivity is achieved. To accomplish this the operator shall:

(1) provide a representative area for a test on any compacted foundation and low-hydraulic-conductivity layers. The following minimum testing procedures shall be performed:

(a) the test pad foundation and, for final covers, the barrier layers shall be compacted with the designated equipment to determine if the specified density/moisture-content/hydraulic-conductivity relationships determined in the laboratory can be achieved in the field with the compaction equipment to be used and at the specified lift thickness;

(2) perform laboratory tests as specified in subsection (e); and

(3) perform field tests as specified in subsection (f). The discharger shall perform hydraulic conductivity tests in the test area under saturated conditions by using the standard test method ASTM Designation: D 3385 94 [9/94], “Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer,” which is incorporated by reference, for vertical hydraulic conductivity measurements. A sufficient number of tests shall be run to verify the results. Other methods that provide an accurate and precise method of measuring field hydraulic conductivity may be utilized as approved by the RWQCB.

(4) Correlations between laboratory tests and test pad results shall be established for each of the various types of fill materials and blends to be used in construction of the actual cover.

(b) Earthen Material Requirements.

(1) The following minimum tests shall include, but not be limited to:

(A) Laboratory tests as specified in (e); and

(B) Field tests as specified in subsections (f and g).

(2) The following minimum testing frequencies shall be performed:

(A) Four (4) field density tests shall be performed for each 1,000 cubic yards of material placed, or at a minimum of four (4) tests per day;

(B) Compaction curve data (ASTM Designation: D 1557 91) graphically represented, and Atterberg limits (ASTM Designation: D 4318 93) shall be performed on the barrier layer material once a week and/or every 5,000 cubic yards of material placed;

(C) For field hydraulic conductivity tests, representative samples shall be performed on barrier layer material;

1. The frequency of testing may be increased or decreased, based on the pass/failure status of previous tests, as approved by the RWQCB.

2. Field infiltration tests shall be performed for the duration necessary to achieve steady conditions for the design hydraulic conductivity.

3. The following interpretive equation shall be used to determine the design hydraulic conductivity:
The infiltration rate \( I \) is defined as:

\[
I = \frac{Q}{(tA)}
\]

where:

- \( Q \) = volume of flow;
- \( t \) = interval of time corresponding to flow \( Q \); and
- \( A \) = area of the ring;

then the hydraulic conductivity \( k \) can be calculated from Darcy's law as follows:

\[
k = \frac{I}{i}
\]

where:

- \( I \) = infiltration rate; and
- \( i \) = hydraulic gradient.

(i) Geosynthetic Membrane Requirements.

(1) Performance requirements for the geosynthetic membrane include, but are not limited to, the following:

- (A) a need to limit infiltration of water, to the greatest extent possible;
- (B) a need to control landfill gas emissions;
- (C) for final covers, mechanical compatibility with stresses caused by equipment traffic, and the result of differential settlement of the waste over time; and
- (D) for final covers, durability throughout the postclosure maintenance period.

(2) Minimum Criteria — The minimum construction quality assurance criteria to ensure that geosynthetic membranes will meet or exceed all design specifications shall include, but not be limited to:

(A) Preconstruction quality control program:

1. inspection of the raw materials (e.g., density, melt flow index, percent carbon Black);
2. manufacturing operations and finished product specifications (e.g., thickness, puncture resistance, multi axial stress/strain tests),
3. fabrication operations (e.g., factory seaming);
4. observations related to transportation, handling, and storage of the geosynthetic membrane; and
5. inspection of foundation preparation;

(B) Construction activities:

1. the geosynthetic membrane shall have thickness strength sufficient to withstand the stresses to which it shall be subjected, including shear forces, puncture from rocks or, for final covers, penetration from roots.
2. inspection of geosynthetic membrane placement (e.g., trench corners, monitoring systems).
3. seaming of the material; and
4. installation of anchors and seals;

(C) Postconstruction Activity — postconstruction activity includes checking for material and placement imperfections in the installed geosynthetic membrane. Imperfections that jeopardize the integrity of the membrane's function as an impermeable barrier (i.e., pin holes, rips, creases created during placement) shall be repaired to the original manufacturer's specifications and reinspected by the CQA officer; and
(D) Evaluation — evaluation of the personnel and equipment to be used to install and inspect the geosynthetic membrane, and pass/fail criteria and corrective procedures for material and installation procedures shall be specified as required in (c).


20330. SWRCB - Liners. (C15: §2542)

(a) Performance Standard — Liners shall be designed and constructed to contain the fluid, including landfill gas, waste, and leachate, as required by Article 3 of this subchapter (§20240 et seq., and §20310).

(b) Clay Liners — Clay liners for a Class II Unit shall be a minimum of 2 feet thick and shall be installed at a relative compaction of at least 90 percent. For a Class III landfill, a clay liner, if required, shall be a minimum of 1 foot thick and shall be installed at a relative compaction of at least 90 percent. For MSW landfills subject to the liner requirements in the federal MSW regulations of 40CFR258, after the Federal Deadline for liners at that Unit, the requirements of this paragraph are superseded by those of SWRCB Resolution No. 93-62 for all portions of the Unit outside the Existing Footprint.

(c) FMLs — Flexible membrane liners ("FMLs," or synthetic liners) shall have a minimum thickness of 40 mils (i.e., 0.040") for an MSW landfill subject to the liner requirements in the federal MSW regulations (40CFR258), after the Federal Deadline for liners at that Unit, the requirements of this paragraph are superseded by those of SWRCB Resolution No. 93-62 for all portions of the Unit outside the Existing Footprint.

(d) Lined Area — Liners shall be installed to cover all natural geologic materials (at the Unit) that are likely to be in contact with waste (including landfill gas or leachate).

(e) S.I. With Replaceable Liner — A Class II surface impoundment may have a single clay liner with a hydraulic conductivity of 1x10^-6 cm/sec (i.e., 1 foot/year) or less if the liner is removed or replaced before the last 25 percent (minimum 1 foot thickness) of the liner is penetrated by fluid, including waste or leachate. The method used to determine seepage velocity shall be included with the calculations of liner penetration.

NOTE: Authority cited: Section 1058, Water Code; Reference: Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.


(a) Basic LCRS Design — Leachate collection and removal systems (LCRS) are required for Class II landfills and surface impoundments, and for Class III landfills which have a liner or which accept sewage or water treatment sludge. The LCRS shall be installed directly above underlying containment features for landfills and waste piles, and installed between the liners for surface impoundments. LCRS requirements are summarized in Table 4.1. Class II landfills and waste piles which contain only dry wastes (not including nonhazardous solid waste and decomposable waste) may be allowed to operate without an LCRS if the discharger demonstrates, based on climatic and hydrogeologic conditions, that leachate will not be formed in, or migrate from, the Unit; nevertheless, for a Class II or Class III MSW landfill, after the Federal Deadline for installing liners at that Unit, the LCRS requirements of SWRCB Resolution No. 93-62 apply to all portions outside of the Unit’s Existing Footprint.

(b) Placement — Except as otherwise provided in (e or f), where an LCRS is used, it shall be installed immediately above the liner (except in the case of a surface impoundment), and between the inner and outer liner of a double liner system, and shall be designed, constructed, maintained, and operated to collect and remove twice the maximum anticipated daily volume of leachate from the Unit.

(c) Head Buildup — The RWQCB shall specify design and operating conditions in WDRs to ensure that there is no buildup of hydraulic head on the liner. The depth of fluid in the collection sump shall be kept at the minimum needed to ensure efficient pump operation.

(d) Clogging — LCRSs shall be designed and operated to function without clogging through the scheduled closure of the Unit and during the post closure maintenance period. The systems shall be tested at least annually to
demonstrate proper operation. The results of the tests shall be compared with earlier tests made under comparable conditions.

(e) Standard LCRS — LCRSs shall consist of a permeable subdrain layer which covers the bottom of the Unit and extends as far up the sides as possible, (i.e., blanket type) except as provided in (f). The LCRS shall be of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and any equipment used at the Unit.

(f) Alternative LCRS — Except as otherwise required for MSW landfills, under SWRCB Resolution No. 93-62, if a Class III landfill is required to have an artificial inner liner and receives only permeable waste that allows free drainage of percolating fluid, the RWQCB can allow the use of a dendritic LCRS which underlies less than 100 percent of the waste; in this type of LCRS system, only wastes which have an hydraulic conductivity which approximates that of subdrain material, and which will remain permeable throughout the active life and post-closure maintenance period of the landfill, shall be placed adjacent to the liner. Furthermore, to prevent ponding, when using this type of LCRS, all portions of the liner not overlain by a portion of the subdrain system shall be sloped toward the subdrain so that ponding is minimized and leachate is removed as quickly as possible from the base of the landfill.

(g) Leachate Handling — Except as otherwise provided under SWRCB Resolution No. 93-62 (for MSW landfills subject to 40CFR258.28), collected leachate shall be returned to the Unit(s) from which it came or discharged in another manner approved by the RWQCB. Collected leachate can be discharged to a different Unit only if:

1. the receiving Unit has an LCRS, contains wastes which are similar in classification and characteristics to those in the Unit(s) from which leachate was extracted, and has at least the same classification (under Article 3 of this subchapter) as the Unit(s) from which leachate was extracted;

2. the discharge to a different Unit is approved by the RWQCB;

3. the discharge of leachate to a different Unit shall not exceed the moisture holding capacity of the receiving unit, and shall comply with §20200(d).

(h) Leachate Production Rate — After July 18, 1997, for a landfill equipped with an LCRS, the discharger shall note, as a part of each regularly scheduled monitoring report [under Article 1, Subchapter 3, Chapter 3 of this division (§20380 et seq.)], the total volume of leachate collected each month since the previous monitoring report.

NOTE: Authority cited: Section 1058, Water Code; Reference: Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

.20360. SWRCB - Subsurface Barriers. (C15: §2545)

(a) Subsurface barriers are cutoff walls or grout curtains which are used in conjunction with natural geologic materials to assure that lateral hydraulic conductivity standards specified in Article 3 of this subchapter are satisfied. Paragraphs (b) and (c) specify conditions under which cutoff walls and grout curtains, respectively, are used.

(b) Cutoff walls.

1. Cutoff walls are required at Class II Units where there is potential for lateral movement of fluid, including waste or leachate, and the hydraulic conductivity of natural geologic materials is used for waste containment in lieu of a liner. Cutoff walls shall be installed at Class III landfills as required by the RWQCB.

2. Cutoff walls shall be:

(A) a minimum of two feet thick for clay materials; or

(B) a minimum of 40 mils (i.e., 0.040") thick for synthetic materials; and

(C) regardless of the option under (b)(2)(A or B), shall be keyed a minimum of five feet into natural geologic material which satisfies the applicable hydraulic conductivity requirements in Article 3 of this subchapter.
(3) If cutoff walls are used, excavations for Units shall be keyed into natural geologic materials which satisfy applicable hydraulic conductivity requirements in Article 3 of this Subchapter.

(4) At closure of a waste pile or surface impoundment, all contaminated natural geologic materials present between the cutoff wall(s) and the waste shall be removed and disposed of at an authorized location, or the Unit shall be closed as a landfill.

(5) Cutoff walls shall have fluid collection systems installed upgradient of the structure. The systems shall be designed, constructed, operated, and maintained to prevent the buildup of hydraulic head against the structure. The collection system shall be inspected regularly, and accumulated fluid shall be removed.

(c) Grout Curtains.

(1) Grout curtains may be used as needed to prevent lateral waste movement through fractures in natural geologic materials that otherwise satisfy applicable hydraulic conductivity requirements in Article 3 of this Subchapter. Only fractures that are at or near the surface and are of limited vertical extent may be grouted.

(2) The acceptability of grout curtains for a Unit shall include consideration of:

   (A) depth and nature of fracturing; and

   (B) fracture orientation.

(3) Grout characteristics shall not be adversely affected by fluid, including waste and leachate, or natural conditions.

(4) Optimum grouting pressure and the placement of grout holes shall be determined by test grouting.


20365. SWRCB - Precipitation and Drainage Controls. [C15: §2546 // T14: §17778(e), (f)(1), (g), & (j)]

(a) General — Units and their respective containment structures shall be designed and constructed to limit to the greatest extent possible, ponding, infiltration, inundation, erosion, slope failure, washout, and overtopping under the precipitation conditions specified in Table 4.1 (of this article) for each class of waste management unit (Unit). [Note: see also §21090(b)(i)].

(b) Undiverted Precipitation — Precipitation on landfills or waste piles which is not diverted by covers or drainage control systems shall be collected and managed through the leachate collection and removal system, which shall be designed and constructed to accommodate precipitation conditions specified in Table 4.1 of this article or each class Unit.

(c) Performance Standards — Diversion and drainage facilities shall be designed, constructed, and maintained:

(1) to accommodate the anticipated volume of precipitation and peak flows from surface runoff under the precipitation conditions specified in Table 4.1 of this article for each class of Unit;

(2) to effectively divert sheet flow runoff laterally, or via the shortest distance, into the drainage and collection facilities;

(3) to prevent surface erosion through the judicious use of:

   (A) energy dissipators where required to decrease the velocity of runoff; and

   (B) slope protection and other erosion control measures;

(4) to control and intercept run-on, in order to isolate uncontaminated surface waters from water that might have come into contact with waste;

(5) to take into account:
(A) for closed Units and for closed portions of Units, the expected final contours of the closed Unit, including its planned drainage pattern;

(B) for operating portions of Units other than surface impoundments, the Unit's drainage pattern at any given time;

(C) the possible effects of the Unit's drainage pattern on and by the regional watershed;

(D) the design capacity of drainage systems of downstream and adjacent properties by providing for the gradual release of retained water downstream in a manner which does not exceed the expected peak flow rate at the point of discharge if there were no waste management facility; and

(6) to preserve the system's function. Therefore, the discharger shall periodically remove accumulated sediment from the sedimentation or detention basins as needed to preserve the design capacity of the system.

(d) Maintain Capacity — Collection and holding facilities associated with precipitation and drainage control systems shall be emptied immediately following each storm or otherwise managed to maintain the design capacity of the system.

(e) Divert Drainage — Surface and subsurface drainage from outside of a Unit shall be diverted from the Unit.

(f) Resist Erosion from Design Storm — Cover materials shall be graded to divert precipitation from the Unit, to prevent ponding of surface water over wastes, and to resist erosion as a result of precipitation with the return frequency specified in Table 4.1 (of this article) for each class of Unit, unless, for a landfill, the CIWMB/EA requires (for protection of public health and safety) that the design be capable of resisting erosion resulting from a longer return interval storm [see §21150(b)]. Any drainage layer in the final cover shall be designed and constructed to intersect with the final drainage system for the Unit in a manner promoting free drainage from all portions of the drainage layer.


.20370. SWRCB - Seismic Design. (C15: §2547)

(a) Class II Units shall be designed to withstand the maximum credible earthquake (MCE) without damage to the foundation or to the structures which control leachate, surface drainage, or erosion, or gas. Class III Units shall be designed to withstand the maximum probable earthquake (MPE) without damage to the foundation or to the structures which control leachate, surface drainage, or erosion, or gas. [Note: see also submittal requirements under §21750(f)(5)].


.20375. SWRCB - Special Requirements for Surface Impoundments. (C15: §2548)

(a) Freeboard — Surface impoundments shall have sufficient freeboard to accommodate seasonal precipitation and the design storm specified in Table 4.1 of this article, but in no case less than 2 feet (measured vertically, from the water surface up to the point on the surrounding lined berm, or dike, having the lowest elevation), and shall be designed and constructed to prevent overtopping as a result of wind conditions likely to accompany such precipitation conditions. The RWQCB can allow a freeboard of less than 2 feet at surface impoundments located on the interior portions of a waste management facility where: 1) these interiormost impoundments are designed such that potential overflows would be reliably conveyed by gravity flow and discharged to other surface impoundments having adequate capacity to receive such diversion without exceeding their respective freeboard limitations; 2) the operation implements a properly developed water balance plan; and 3) the facility is provided with a fail safe emergency retention area solely for the purpose of containing wastes due to surface impoundment failures.
(b) Operation Plan — An operation plan shall be submitted to the RWQCB which will provide operation levels and waste input quantities permitted each month based on anticipated precipitation and on past precipitation conditions for the year.

(c) Fail-Safe — Direct pipeline discharge to surface impoundments shall be either equipped with devices or shall have fail safe operating procedures to prevent overfilling. Discharges shall be stopped in the event of any containment system failure which causes a threat to water quality.

(d) Unauthorized Discharges — There shall be no discharge from a surface impoundment except as authorized by WDRs.

(e) Scour Protection — Surface impoundments shall be designed and constructed to prevent scouring of containment structures at points of discharge into the impoundments and by wave action at the waterline.

(f) Liner Inspections — All visible portions of synthetic liners shall be inspected weekly until all free liquid is removed from the surface impoundment as part of closure pursuant to §21400(a). If, during the active life of the impoundment, the wastes are removed and the bottom of the impoundment is cleaned down to the liner, an inspection shall be made of the bottom of the liner prior to refilling of the impoundment.

NOTE: Authority cited: Section 1058, Water Code; Reference: Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

.20377. SWRCB - Special Requirements for Land Treatment Units (LTUs). (C15: §2549)
(a) General — Dischargers operating LTUs shall comply with the general criteria specified in §§20320(a & d), with the precipitation and drainage controls specified in §20365, and with the seismic design criteria in §20370.

(b) Performance Standard — Dischargers shall design, construct, operate, and maintain LTUs to maximize the degradation, transformation, and immobilization of waste constituents in the treatment zone. Dischargers shall design, construct, operate, and maintain units in accord with all design and operating conditions that were used in treatment demonstrations under §20250.

NOTE: Authority cited: Section 1058, Water Code; Reference: Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

Subchapter 3. Water Monitoring

[Note: For gas monitoring at landfills, see Article 6, Subchapter 4 of this chapter. For final cover monitoring at landfills, see §21090(a)(4).]

Article 1. SWRCB - Water Quality Monitoring and Response Programs for Solid Waste Management Units

.20380. SWRCB - Applicability. (C15: §2550.0)
(a) The regulations in this article apply to owners or operators of facilities that treat, store, or dispose of waste at waste management units. The owner or operator of a surface impoundment, waste pile, landfill, or land treatment unit that receives or has received waste (hereinafter referred to as "waste management units," or "Units") that is subject to the SWRCB-promulgated requirements of this division, pursuant to §§20080 and 20090 shall comply with the provisions of this article for purposes of detecting, characterizing, and responding to releases to ground water, surface water, or the unsaturated zone. Furthermore, §20400 of this article also applies to all determinations of alternative cleanup levels for unpermitted discharges to land of solid waste, pursuant to III.G. of SWRCB Resolution No. 92-49 [§2550.4 of Title 23 of this code serves a similar function for unpermitted discharges to land of hazardous waste].

(b) Known or Reasonably Foreseeable Release — In accordance with applicable requirements of §§22220- 22222, waste discharge requirements (WDRs) for a Unit subject to this section shall contain a provision which requires the discharger to obtain and maintain assurances of financial responsibility for initiating and completing corrective action for all known or reasonably foreseeable releases from the Unit.
(c) [Reserved]

(d) Apply Unless Clean-Closed — The regulations under this article apply during the Unit’s active life and closure period. After closure of the Unit, the regulations in this article apply during the post closure maintenance period of the Unit and during any compliance period under §20410 of this article, unless:

(1) the Unit has been in compliance with the water quality protection standard (“Water Standard” of §20390) for a period of three consecutive years; and

(2) Clean-Closure — all waste, waste residues, contaminated containment system components, contaminated subsoils, and all other contaminated materials are removed or decontaminated at closure, pursuant to: §21090(f), for landfills; §21400(b)(1), for surface impoundments; or §21410(a)(1), for waste piles.

(e) Allowable Engineered Alternatives — In considering a monitoring proposal by the discharger, the RWQCB can allow an engineered alternative for any of the prescriptive standards in this article so long as the RWQCB:

(1) finds that each engineered alternative meets the requirements of §20080(b & c);

(2) finds, for each applicable program under §20385, that the discharger’s proposed monitoring-data procurement and analysis methods achieve the program’s respective goals, including:

(A) for a detection monitoring program, the goals articulated in §20420(b);

(B) for an evaluation monitoring program, the goals articulated in §20425(a)(2); and

(C) for a corrective action program, the goals articulated in §20430(b);

(3) requires ground water monitoring at least annually at disposal Units and at Units that will be used for five or more years for waste treatment or storage.


.20385. SWRCB - Required Programs. (C15: §2550.1)

(a) Monitoring Programs & their Respective Triggers — A discharger subject to this article shall conduct a monitoring and response program, approved by the RWQCB, for each Unit at the facility as follows.

(1) Detection Monitoring (default) — The discharger shall institute a detection monitoring program (under §20420) except as required below under .(a)(2-4);

(2) Evaluation Monitoring (trigger #1) — The discharger shall institute an evaluation monitoring program (under §20425) whenever there is “measurably significant” (see §20164) evidence of a release from the Unit during a detection monitoring program [under §20420(g or i)];

(3) Evaluation Monitoring (trigger #2) — The discharger shall institute an evaluation monitoring program (under §20425) whenever there is significant physical evidence of a release from the Unit. Significant physical evidence of a release includes unexplained volumetric changes in surface impoundments, unexplained stress in biological communities, unexplained changes in soil characteristics, visible signs of leachate migration, and unexplained water table mounding beneath or adjacent to the Unit and any other change to the environment that could reasonably be expected to be the result of a release from the Unit; and

(4) Corrective Action — The discharger shall institute a corrective action program under §20430 of this article when the RWQCB determines (pursuant to §20425) that the assessment of the nature and extent of the release and the design of a Corrective Action Program have been satisfactorily completed and the RWQCB approves the application for an amended report of waste discharge for corrective action submitted by the discharger during an evaluation monitoring program [pursuant to §20425(d)].

(b) Preparation for Other Programs — The RWQCB shall specify in the WDRs the specific type or types of monitoring programs required and the specific elements of each monitoring and response program. For each Unit,
the RWQCB shall require one or more of the programs identified in (a) that is appropriate for the prevailing state of containment at the Unit, and shall specify the circumstances under which each of the programs will be required. In deciding whether to require the discharger to be prepared to institute a particular program, the RWQCB shall consider the potential adverse effects on human health or the environment that might occur before final administrative action on an amended report of waste discharge to incorporate such a program could be taken.

(c) Concurrent Detection Monitoring Program, Where Necessary — In conjunction with an evaluation monitoring program or a corrective action program, the discharger shall continue to conduct a detection monitoring program as necessary to provide the best assurance of the detection of subsequent releases from the Unit.


.20390. SWRCB - Water Quality Protection Standard (Water Standard). (C15: §2550.2)
(a) Components & Duration — For each Unit, the RWQCB shall establish a water quality protection standard (Water Standard) in the WDRs. This Water Standard shall consist of the list of constituents of concern (under §20395), the concentration limits (under §20400), and the Point of Compliance and all Monitoring Points (under §20405). This Water Standard shall apply during the active life of the Unit, the closure period, the post closure maintenance period, and during any compliance period (under §20410).

(b) Program-Specific Water Standards — If a discharger is conducting a detection monitoring program in conjunction with a corrective action program for a Unit (pursuant to §20385(e)), the RWQCB may establish separate Water Standards for each program.


.20395. SWRCB - Constituents of Concern (COCs). (C15: §2550.3)
(a) COCs — For each Unit, the RWQCB shall specify in the WDRs the Constituents of Concern (COCs) to which the Water Standard (under §20390) applies. The COC list shall include all waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the Unit.

(b) MSW COCs — For MSW landfills, the COC list shall include all constituents mandated under SWRCB Resolution No. 93-62.


.20400. SWRCB - Concentration Limits. (C15: §2550.4)
[Note: The special applicability of this section is described in §20380(a); see also §20080(a).]
(a) Proposal of Concentration Limits — For each Constituent of Concern (COC) specified pursuant to §20395 (or for a solid waste constituent that is addressed by a cleanup and abatement action taken pursuant to SWRCB Resolution No. 92-49), the discharger shall propose one of the following for each medium (under §20415, including ground water, surface water, and the unsaturated zone) monitored pursuant to §20415 of this article:

1. Background Value — a concentration limit not to exceed the background value of that constituent as determined pursuant to §20415(e)(10)(A);

2. Value Redetermined Each Time — that the WDRs include a statement that, at any given time, the concentration limit for that COC will be equal to the background value of that constituent, as determined pursuant to §20415(e)(10)(B); or
(3) CLGB — a concentration limit greater than background (CLGB) established pursuant to this section for a corrective action program.

(b) Adoption of Concentration Limits — The RWQCB shall review the proposed concentration limits and statements and shall approve, modify, or disapprove each proposed limit and each proposed statement. Upon final approval by the RWQCB, each concentration limit and each statement shall be specified in WDRs. The RWQCB shall approve more than one concentration limit for different Monitoring Points in the same medium only if:

1. more than one background condition exists within a particular medium;
2. the statistical method approved for a constituent uses intra well comparisons procedures; or
3. CLGBs have been established for a corrective action program at the Monitoring Points in the zone affected by a release from the Unit.

(c) Establishing a CLGB — For a corrective action program, the RWQCB shall establish a CLGB [under .(a)(3)] only if the RWQCB finds that it is technologically or economically infeasible to achieve the background value for that constituent and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the CLGB is not exceeded. In making this finding, the RWQCB shall consider the factors specified in .(d), the results of the engineering feasibility study submitted pursuant to §20425(e), data submitted by the discharger pursuant to §20425(d)(2) to support the proposed CLGB, public testimony on the proposal, and any additional data obtained during the evaluation monitoring program.

(d) Considerations — In establishing a CLGB for a constituent of concern, the RWQCB shall consider the following factors:

1. potential adverse effects on ground water quality and beneficial uses, considering:
   (A) the physical and chemical characteristics of the waste in the Unit;
   (B) the hydrogeological characteristics of the facility and surrounding land;
   (C) the quantity of ground water and the direction of ground water flow;
   (D) the proximity and withdrawal rates of ground water users;
   (E) the current and potential future uses of ground water in the area;
   (F) the existing quality of ground water, including other sources of contamination or pollution and their cumulative impact on the ground water quality;
   (G) the potential for health risks caused by human exposure to waste constituents;
   (H) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and
2. potential adverse effects on surface water quality and beneficial uses, considering:
   (A) the volume and physical and chemical characteristics of the waste in the Unit;
   (B) the hydrogeological characteristics of the facility and surrounding land;
   (C) the quantity and quality of ground water and the direction of ground water flow;
   (D) the patterns of precipitation in the region;
   (E) the proximity of the Unit to surface waters;
   (F) the current and potential future uses of surface waters in the area;
   (G) the existing quality of surface water including other sources of contamination or pollution and the cumulative impact on surface water quality;
   (H) the potential for health risks caused by human exposure to waste constituents;
(l) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(j) the persistence and permanence of the potential adverse effects.

(e) CLGB Ceiling — In no event shall a CLGB for a constituent of concern exceed the lowest concentration that the discharger demonstrates and the RWQCB finds is technologically and economically achievable. No provision of this section shall be taken to allow a CLGB for a constituent of concern to exceed the maximum concentration that would be allowed under other applicable statutes or regulations (e.g., Maximum Concentration Limits established under the federal Safe Drinking Water Act (P.L. 93 523, codified as Subchapter XII of the Public Health Service Act at 42 USC 300f, et seq.; regulations establishing MCLs are located in 40 CFR Part 141, Subpart B), etc.).

(f) Receptor Location — For ground water, in evaluating risk pursuant to (d) to any biological receptor, the risk shall be evaluated as if exposure would occur at the Point of Compliance.

(g) Additivity — Proposals for CLGBs shall include a demonstration that the aggregate of hazardous constituents in the environment will not result in excessive exposure to a sensitive biological receptor. In the absence of scientifically valid data to the contrary, theoretical risks from chemicals associated with the release from the Unit shall be considered additive across all media of exposure, and shall be considered additive for all chemicals having similar toxicological effects or having carcinogenic effects.

(h) Applicability — A CLGB may only be applied during corrective action, or during detection monitoring following corrective action, at Monitoring Points at which “measurably significant” (see §20164) evidence of the release has been determined.

(i) Decreasing the CLGB — When a detection monitoring program incorporating a CLGB is reinstated after a corrective action program has been terminated, each CLGB shall be re evaluated during each review of WDRs or at least every five years. If the RWQCB, upon re evaluation, determines that the concentration of a constituent of concern in ground water, surface water, or the unsaturated zone is lower than its associated concentration limit by a “measurably significant” (see §20164) amount, the concentration limit for that constituent shall be lowered to reflect current water quality.


.20405. SWRCB - Monitoring Points and the Point of Compliance. (C15: §2550.5)

(a) For each Unit, the RWQCB shall specify in the WDRs the Point of Compliance at which the Water Standard (of §20390) applies. The Point of Compliance is a vertical surface located at the hydraulically downgradient limit of the Unit that extends through the uppermost aquifer underlying the Unit. For each Unit, the RWQCB shall specify Monitoring Points (as defined in §20164) along the Point of Compliance, and shall specify additional Monitoring Points at locations determined pursuant to §20415(b-d) at which the Water Standard under §20390 applies and at which monitoring shall be conducted.

(b) If the facility contains contiguous Units and monitoring along a shared boundary would impair the integrity of a containment or structural feature of any of the Units, the Point of Compliance may be located at the hydraulically downgradient limit of an area described by an imaginary line along the outer boundary of the contiguous Units. This provision only applies to contiguous Units that have operated or have received all permits necessary for construction and operation before 7-1-91.


.20410. SWRCB - Compliance Period. (C15: §2550.6)

(a) The RWQCB shall specify in WDRs a compliance period for each Unit. The compliance period is the number of years equal to the active life of the Unit (including any waste management activity prior to the adoption
of the WDRs) plus the closure period. The compliance period is the minimum period of time during which the discharger shall conduct a water quality monitoring program subsequent to a release from the Unit.

(b) The compliance period begins anew each time the discharger initiates an evaluation monitoring program (under §20425).

(c) If the discharger is engaged in a corrective action program at the scheduled end of the compliance period specified under .(a), the compliance period shall be extended until the discharger can demonstrate that the Unit has been in continuous compliance with its Water Standard (under §20390) for a period of three consecutive years.


.20415. SWRCB - General Water Quality Monitoring and System Requirements. [C15: §2550.7 // T15: §17783.5(d)]

(a) The discharger shall comply with the requirements of this section for any water quality monitoring program developed to satisfy §20420, §20425, or §20430 of this article.

(b) Ground Water Monitoring System.

1. General — Except as provided under .(e)(3), the discharger shall establish a ground water monitoring system for each Unit. This ground water monitoring system shall include:

   (A) For All Programs — for all monitoring and response programs, a sufficient number of Background Monitoring Points (as defined in §20164) installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water that has not been affected by a release from the Unit;

   (B) For DMP — for a detection monitoring program under §20420:

      1. a sufficient number of Monitoring Points (as defined in §20164) installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and to allow for the detection of a release from the Unit;

      2. a sufficient number of Monitoring Points installed at additional locations and depths to yield ground water samples from the uppermost aquifer to provide the best assurance of the earliest possible detection of a release from the Unit;

      3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to .(b)(1)(B). and .(b)(1)(B)2., to provide the best assurance of the earliest possible detection of a release from the Unit;

      4. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the best assurance of the earliest possible detection of a release from the Unit; and

      5. Monitoring Point locations and depths that include the zone(s) of highest hydraulic conductivity in each ground water body monitored pursuant to this subsection [i.e., under .(b), inclusive].

   (C) For EMP — for an evaluation monitoring program under §20425:

      1. a sufficient number of Monitoring Points installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and at other locations in the uppermost aquifer to provide the data needed to evaluate changes in water quality due to the release from the Unit;

      2. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to .(b)(1)(C)1., to provide the data needed to evaluate changes in water quality due to the release from the Unit; and
3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the data needed to evaluate changes in water quality due to the release from the Unit; and

(D) For CAP — for a corrective action program under §20430:
1. a sufficient number of Monitoring Points installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and at other locations in the uppermost aquifer to provide the data needed to evaluate the effectiveness of the corrective action program;

2. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to .(b)(1)(D)1., to provide the data needed to evaluate the effectiveness of the corrective action program; and

3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the data needed to evaluate the effectiveness of the corrective action program.

(2) Alternate Background Locations — The ground water monitoring system may include Background Monitoring Points that are not hydraulically upgradient of the Unit if the discharger demonstrates to the satisfaction of the RWQCB that sampling at other Background Monitoring Points will provide samples that are representative of the background quality of ground water or are more representative than those provided by the upgradient Background Monitoring Points.

(3) Drillers’ Logs — Copies of drillers’ logs which the Department of Water Resources requires to be submitted pursuant to §13751 of the California Water Code shall be submitted to the RWQCB.

(4) Monitoring Well Performance Standards.
(A) All monitoring wells shall be cased and constructed in a manner that maintains the integrity of the monitoring well bore hole and prevents the bore hole from acting as a conduit for contaminant transport.

(B) The sampling interval of each monitoring well shall be appropriately screened and fitted with an appropriate filter pack to enable collection of representative ground water samples.

(C) For each monitoring well, the annular space (i.e., the space between the bore hole and well casing) above and below the sampling interval shall be appropriately sealed to prevent entry of contaminants from the ground surface, entry of contaminants from the unsaturated zone, cross contamination between portions of the zone of saturation, and contamination of samples.

(D) All monitoring wells shall be adequately developed to enable collection of representative ground water samples.

(c) Surface Water Monitoring Systems.
(1) General — The discharger shall establish a surface water monitoring system to monitor each surface water body that could be affected by a release from the Unit.

(2) Each Monitored Surface Water Body — Each surface water monitoring system shall include:
(A) Background Monitoring Points — a sufficient number of Background Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that represent the quality of surface water that has not been affected by a release from the Unit;

(B) For DMP — for a detection monitoring program (under §20420), a sufficient number of Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that provide the best assurance of the earliest possible detection of a release from the Unit;

(C) For EMP — for an evaluation monitoring program (under §20425), a sufficient number of Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that provide the data to evaluate changes in water quality due to the release from the Unit; and
initial determinations backed up by laboratory work under ASTM Designation "D2487-93 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)," available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

(B) Rock shall be described in the geologic log in a manner appropriate for the purpose of the investigation.

(C) Where possible, the depth and thickness of saturated zones shall be recorded in the geologic log.

(3) Shared Systems — If a facility contains contiguous Units, separate ground water monitoring systems are not required for each such Unit if the discharger demonstrates to the satisfaction of the RWQCB that the water quality monitoring program for each Unit will enable the earliest possible detection and measurement of a release from that Unit.

(4) QA/QC — The water quality monitoring program shall include consistent sampling and analytical procedures that are designed to ensure that monitoring results provide a reliable indication of water quality at all Monitoring Points and Background Monitoring Points. At a minimum, the program shall include a detailed description of the procedures and techniques for:

(A) sample collection, including purging techniques, sampling equipment, and decontamination of sampling equipment;

(B) sample preservation and shipment;

(C) analytical procedures; and

(D) chain of custody control.

(5) Sampling & Analytical Methods — The water quality monitoring program shall include appropriate sampling and analytical methods for ground water, surface water, and the unsaturated zone that accurately measure the concentration of each COC and the concentration or value of each Monitoring Parameter.

(6) Initial Background Sampling — For each Unit, the discharger shall collect all data necessary for selecting the appropriate data analysis methods pursuant to .(e)(7-9) and for establishing the background values specified pursuant to .(e)(10). At a minimum, this data shall include analytical data obtained during quarterly sampling of all Background Monitoring Points for a period of one year, including the times of expected highest and lowest annual elevations of the ground water surface. For a new Unit, this data shall be collected before wastes are discharged at the Unit and background soil pore liquid data shall be collected from beneath the Unit before the Unit is constructed.

(7) Propose Data Analysis Method(s) — Based on data collected pursuant to .(e)(6), the discharger shall implement data analysis methods allowed in .(e)(8) for each COC and for each Monitoring Parameter. The data analysis methods shall be used in evaluating water quality monitoring data. The specifications for each data analysis method shall include a detailed description of the criteria to be used for determining "measurably significant" (as that term is defined in §20164) evidence of any release from the Unit and for determining compliance with the Water Standard. Each statistical test specified for a particular COC or Monitoring Parameter shall be conducted for that COC or Monitoring Parameter at each Monitoring Point. Where practical quantitation limits (PQLs) are used in any of the following data analysis methods to comply with .(e)(9)(E), the discharger shall identify the PQL to the RWQCB. The discharger shall:

(A) continue using the methods specified in the existing M&R; or

(B) submit to the RWQCB, before implementing the selected methods, a comprehensive technical report, certified by an appropriately registered professional, documenting that use of the proposed data analysis methods will comply with the performance standards outlined in .(e)(9, 10, & 12):

1. the RWQCB shall audit selected reports submitted pursuant to this subdivision for compliance and applicability, as deemed necessary by the RWQCB; and

2. the discharger shall not change the data analysis methods developed pursuant to this subdivision until the next review/update of the M&R, unless directed to make changes by the RWQCB; or
5. Retest Effects on Type I Error Rate — the Type I error for statistical methods employing a retest procedure shall be as follows:

   a. When Initial Test = Retest — in cases where the discharger proposes to use the same statistical test for both the initial test and the retest, either:

      i. ∀ for Composite Retest — for a verification procedure containing a composite retest, the statistical test method used in the verification procedure shall be conducted at a Type I error rate of no less than 0.05 for both the experiment wise analysis (if any) and the individual Monitoring Point comparisons. Therefore, if a control chart approach is used to evaluate water quality monitoring data, the upper limit on an X Bar or R Chart must be set at no more than 1.645 standard deviations of the statistic plotted for a one sided statistical comparison or at no more than 1.96 standard deviations of the statistic plotted for a two sided statistical comparison; or

      ii. ∀ for Discrete Retest (& Original Test Too) — For a verification procedure containing discrete retests, the statistical test method used shall be the same as the method used in the initial statistical comparison. Notwithstanding any provision of .(c)(9), the critical value for the tests shall be chosen so that the Type I error rate for all individual monitoring point comparisons is the same, whether for an initial test or for a retest, and is equal to or greater than either

      \[
      (1-0.95)^{1/(M^{\frac{W}{S}})} \times (1/R)^{0.5}, \text{ or} \\
      1-(0.99)^{1/S},
      \]

      whichever is larger, where: \(M\) = the number of Monitoring Parameters (or COCs, as appropriate) being tested by statistical methods during that Reporting Period; \(W\) = the total number of Monitoring Points at the Unit (considering all monitored media); \(S\) = the number of times that suites of monitoring data from the Unit are subjected to initial statistical analysis within a period of six months (i.e., for Monitoring Parameter testing, \(S^1\), but for COC testing, \(S^2\)); and \(R\) = the number of discrete retests that are to be conducted at a Monitoring Point for a given COC or Monitoring Parameter whose initial statistical analysis, at that Monitoring Point, has indicated the presence of a release (i.e., \(R^2\)); or

   b. When Retest Differs From Initial Test Method — in cases where the discharger proposes to use a different statistical test for the composite or discrete retest than that which provided the initial indication of a release (e.g., parametric Tolerance Limit test facility-wide, following by a parametric Prediction Limit retest for any indicating Monitoring Point), the individual Monitoring Point error level requirements of .(e)(9)(B) do not apply. Nevertheless, the discharger shall demonstrate that the initial and retest method, in combination, provide:

      i. a facility-wide false positive rate of <5%, for the indicated COC or Monitoring Parameter; and

      ii. a statistical power equivalent to or better than the USEPA Reference Power Curve (see Section 5 and Appendix B of “Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities C Addendum To Interim Final Guidance”, USEPA Office of Solid Waste, Washington, D.C., July, 1992), which is hereby incorporated by reference.

6. Reporting — the discharger shall report to the RWQCB by certified mail the results of both the initial statistical test and the results of the verification procedure, as well as all concentration data collected for use in these tests within seven days of the last laboratory analysis of the samples collected for the verification procedure; and

7. Scope — the verification procedure shall only be performed for the constituent(s) or parameters which has shown “measurably significant” (see §20164) evidence of a release, and shall be performed for those Monitoring Points at which a release is indicated.
(9) Data Analysis Method Performance Standards — In cases where the discharger proposes to use a non-statistical data analysis method, the discharger shall demonstrate that it meets the performance standard given in the leading paragraph of .(e)(8). Each statistical method chosen under .(e)(7) for specification in the WDRs shall comply with the following performance standards for each six month period:

(A) Fit & Performance — the statistical method used to evaluate water quality monitoring data shall be appropriate for the distribution of the COC or Monitoring Parameter to which it is applied and shall be the least likely of the appropriate methods to fail to identify a release from the Unit. If the distribution of a COC or Monitoring Parameter is shown by the discharger to be inappropriate for a normal theory test, then the data shall be either transformed so that the distribution of the transformed data is appropriate for a normal theory test or a distribution free theory test shall be used. If the distributions for the COC or Monitoring Parameters differ, more than one statistical method may be needed.

(B) ∀ Level — if an individual Monitoring Point comparison procedure is used to compare an individual Monitoring Point constituent concentration or Monitoring Parameter value with a concentration limit in the Water Standard or with a background Monitoring Parameter value, the test shall be done at a Type I error rate (ν, as a decimal fraction) no less than 0.01. If a multiple comparisons procedure is used, the Type I experiment wise error rate (experiment-wise ν) shall be no less than 0.05; however, a Type I error rate of no less than 0.01 for individual Monitoring Point comparisons shall be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, control charts, or any method using discrete retests for ∀ levels applicable to the latter case, see .(c)(8)(E)(5.b.);

(C) Control Chart Rate — if a control chart approach is used to evaluate water quality monitoring data, the specific type of control chart and its associated statistical parameter values (e.g., the upper control limit) shall be included in the supporting documentation under .(e)(7). The discharger shall use the procedure only if the discharger’s supporting documentation under .(e)(7) shows the procedure to be protective of human health and the environment. Any control charting procedure must have a false positive rate of no less than 1 percent for each Monitoring Point charted (e.g., upper control limits on X bar or R Charts used only once every six months must be set at no more than 2.27 standard deviations of the statistic plotted for a one sided statistical comparison or at no more than 2.576 standard deviations of the statistic plotted for a two sided statistical comparison);

(D) Tol. Int./Pred. Int. Rate — if a tolerance interval or a prediction interval is used to evaluate water quality monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain shall be proposed by the discharger and included in the technical documentation submitted to the RWQCB pursuant to .(e)(7). The discharger can use the parameters only if the documentation submitted under .(e)(7) shows these statistical parameters to be protective of human health and the environment. These statistical parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentrations or values for each COC or Monitoring Parameter. The coverage of any tolerance interval used shall be no more than 95 percent and the confidence coefficient shall be no more than 99 percent for a six month period. Prediction intervals shall be constructed with an experiment wise error rate of no less than 5 percent and an individual monitoring point error rate of no less than 1 percent;

(E) Addressing Censored Data — the statistical method shall account for data below the practical quantitation limit with one or more statistical procedures that are protective of human health and the environment. Any practical quantitation limit validated pursuant to .(e)(7) that is used in the statistical method shall be the lowest concentration (or value) that can be reliably achieved within limits of precision and accuracy specified in the WDRs for routine laboratory operating conditions that are available to the facility. The discharger’s technical report, under .(e)(7) shall consider the practical quantitation limits listed in Appendix IX to Chapter 14 of Division 4.5 of Title 22, California Code of Regulations (Appendix IX) for guidance when specifying limits of precision and accuracy in the WDRs;

(F) Seasonal/Spatial Variability — if necessary, the statistical methods shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data; and

(G) Outliers — any quality control procedure that is declared for use, in the technical report under .(e)(7), for application to water quality data from downgradient monitoring points for a monitored medium shall also be
applied to all newly acquired background data from that medium. Any newly acquired background monitoring
datum that is rejected by an approved quality control procedure shall be maintained in the facility record but shall
be excluded from use in statistical comparisons with downgradient water quality data.

(10) Background Values/Procedures — Based on the data collected pursuant to .(e)(6) and the data analysis
methods addressed in the technical report under .(e)(7), the discharger shall justify the use of a procedure for
determining a background value for each COC and for each Monitoring Parameter specified in the WDRs. These
procedures shall be proposed for ground water, surface water, and the unsaturated zone. The discharger shall
declare and substantiate one of the following methods in the technical report under .(e)(7):

(A) By Reference to Historical Data — a procedure for determining a background value for each constituent
or parameter that does not display appreciable variation; or

(B) By Using a Formula/Procedure — a procedure for establishing and updating a background value for a
constituent or parameter to reflect changes in the background water quality if the use of contemporaneous or
pooled data provides the greatest power to the data analysis method for that constituent or parameter.

(11) [Reserved]

(12) Sampling Methods — For each COC and Monitoring Parameter listed in the WDRs, the discharger shall verify,
in the technical report under .(e)(7), that the sampling methods to be used to establish background values
and the sampling methods to be used for monitoring pursuant to this article are consistent with the following:

(A) Sample Size — the number and kinds of samples collected shall be appropriate for the form of data
analysis employed and, in the case of statistical data analysis shall follow generally accepted statistical principles.
The “sample size” (i.e., the number of water quality data points representing a given Monitoring Point or
Background Monitoring Point) approved for the data analysis method shall be as large as necessary to ensure with
reasonable confidence that:

1. for a detection monitoring program, a release from the Unit will be detected;
2. for an evaluation monitoring program, changes in water quality due to a release from the Unit will be
recognized; and
3. for a corrective action program, compliance with the water quality protection standard and effectiveness of
the corrective action program will be determined; and

(B) Data Collection & Analysis — the sampling method (including the sampling frequency and the interval
of time between successive samples) shall be appropriate for the medium from which samples are taken (e.g.,
ground water, surface water, and soil pore liquid). For ground water, sampling shall be scheduled to include the
times of expected highest and lowest elevations of the potentiometric surface. The sampling method shall assure, to
the greatest extent possible, that independent samples are obtained. For ground water, the discharger can use a
post-sampling purge to assure sample independence whenever the time between successive sampling events (for a
given COC or Monitoring Parameter) is insufficient to ensure sample independence, in which case the volume of
well water to be withdrawn from the well bore for the post sampling purge shall be determined by the same method
used to determine adequate pre sampling purging. The sampling method selected shall include collection of at least
the appropriate number of new data points [pursuant to .(e)(12)(A)] at least semi annually from each Monitoring
Point and background monitoring point and data analysis carried out at least semi annually. The RWQCB shall
require more frequent sampling and statistical analysis than is stated in the discharger's technical report under
.(e)(7) where necessary to protect human health or the environment.

(13) Elevation & Field Parameters — The ground water portion of the monitoring program shall include an
accurate determination of the ground water surface elevation and field parameters (temperature, electrical
conductivity, turbidity, and pH) at each well each time ground water is sampled.

(14) Annual Data Graphs — The discharger shall graph all analytical data from each Monitoring Point and
Background Monitoring Point and shall submit these graphs to the RWQCB at least once annually, except that
graphs are not required for constituents for which no new data has been collected since the previous graph
submittal. Graphs shall be at a scale appropriate to show trends or variations in water quality. All graphs for a
given constituent shall be plotted at the same scale to facilitate visual comparison of monitoring data. Unless the discharger receives written approval from the RWQCB to use an alternate procedure that more effectively illustrates trends or variations in the data, each graph shall represent data from one Monitoring Point or Background Monitoring Point and one Constituent of Concern or Monitoring Parameter.

(15) **G.W. Flow Direction** — In addition to the water quality sampling conducted pursuant to the requirements of this article, the discharger shall measure the water elevation in each well and determine ground water flow rate and direction in the uppermost aquifer and in any zones of perched water and in any additional portions of the zone of saturation monitored pursuant to .(b)(1) at least quarterly, including the times of expected highest and lowest elevations of the water levels in the wells.

(16) **Operating Record** — Water quality monitoring data collected in accordance with this article, including actual values of constituents and parameters, shall be maintained in the facility operating record. The RWQCB shall specify in the WDRs when the data shall be submitted for review.


20420. SWRCB - Detection Monitoring Program. (C15: §2550.8)

(a) **General** — A discharger required, pursuant to §20385, to establish a detection monitoring program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(b) **Standards** — The discharger subject to this section shall install water quality monitoring systems that are appropriate for detecting, at the earliest possible time, a release from the Unit, and that comply with applicable provisions of §20415.

(c) **Background** — The discharger shall establish a background value pursuant to §20415(e)(10) for each Monitoring Parameter specified pursuant to .(e) and for each Constituent of Concern under §20395.

(d) **Water Standard** — The RWQCB shall specify the Water Standard under §20390 in the WDRs.

(e) **Monitoring Parameters** — The discharger shall propose for approval by the RWQCB a list of Monitoring Parameters for each medium (ground water, surface water, and the unsaturated zone) to be monitored pursuant to .(1) and §20415, including a data analysis method meeting the requirements of that section for each Monitoring Parameter. The list for each monitored medium shall include those physical parameters, hazardous constituents, waste constituents, and reaction products that provide a reliable indication of a release from the Unit to that medium. In addition, for an MSW landfill, the list of monitoring parameters shall meet the requirements of SWRCB Resolution No. 93-62 (which incorporates by reference the federal requirements of 40CFR258.54). The RWQCB shall specify each list of Monitoring Parameters in the WDRs after considering the following factors:

1. the types, quantities, and concentrations of constituents in wastes managed at the Unit;
2. the expected or demonstrated correlation between the proposed Monitoring Parameters and the Constituents of Concern specified for the Unit under §20395;
3. the mobility, stability, and persistency of waste constituents of their reaction products;
4. the detectability of physical parameters, waste constituents, and reaction products; and
5. the background values and the coefficients of variation of proposed Monitoring Parameters in ground water, surface water, and the unsaturated zone.

(f) **Routine Monitoring** — The discharger shall monitor [pursuant to .(i)] for the Monitoring Parameters listed in the WDRs pursuant to .(e). The RWQCB shall specify the frequencies for collecting samples and for analyzing the resulting data, pursuant to §20415(e)(12).

(g) **Five-Yearly COC Monitoring** — In addition to monitoring for the Monitoring Parameters specified pursuant to .(e), the discharger shall periodically monitor for COCs specified in the WDRs, and shall determine, pursuant to .(i), whether there is “measurably significant” (see definition in §20164) evidence of a release for any
(A) COC Concentrations — the maximum concentration of each COC at each Monitoring Point as determined during the most recent COC sampling event [i.e., under .(g) or .(k)(1)];

(B) Proposed Monitoring System Changes — any proposed changes to the water quality monitoring systems at the Unit necessary to meet the provisions of §20425;

(C) Proposed Monitoring Changes — any proposed additions or changes to the monitoring frequency, sampling and analytical procedures or methods, or statistical methods used at the Unit necessary to meet the provisions of §20425; and

(D) Proposed Delineation Approach — a detailed description of the measures to be taken by the discharger to assess the nature and extent of the release from the Unit;

(6) Submit Initial EFS — within 180 days of determining measurably significant evidence of a release, submit to the RWQCB an engineering feasibility study for a corrective action program necessary to meet the requirements of §20430. At a minimum, the feasibility study shall contain a detailed description of the corrective action measures that could be taken to achieve background concentrations for all Constituents of Concern; and

(7) Optional Demonstration (That Unit Is Not At Cause) — if the discharger determines, pursuant to .(i), that there is “measurably significant” (see §20164) evidence of a release from the Unit at any Monitoring Point, the discharger may demonstrate that a source other than the Unit caused the evidence of a release or that the evidence is an artifact caused by an error in sampling, analysis, or statistical evaluation or by natural variation in the ground water, surface water, or the unsaturated zone. The discharger may make a demonstration pursuant to this subsection in addition to or in lieu of submitting both an amended report of waste discharge pursuant to .(k)(5) and an engineering feasibility study pursuant to .(k)(6); however, the discharger is not relieved of the requirements specified in .(k)(5) and .(k)(6) unless the demonstration made pursuant to this subsection successfully shows that a source other than the Unit caused the evidence of a release or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone. In making a demonstration pursuant to this subsection, the discharger shall:

(A) Notification of Intent — within seven days of determining “measurably significant” (see §20164) evidence of a release, notify the RWQCB by certified mail that the discharger intends to make a demonstration pursuant to this subsection .(k)(7));

(B) Demonstration Due Date — within 90 days of determining “measurably significant” (see §20164) evidence of a release, submit a report to the RWQCB that demonstrates that a source other than the Unit caused the evidence, or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone;

(C) Amended ROWD — within 90 days of determining “measurably significant” (see §20164) evidence of a release, submit to the RWQCB an amended report of waste discharge to make any appropriate changes to the detection monitoring program; and

(D) DMP Continues — continue to monitor in accordance with the detection monitoring program established pursuant to this section.

(I) Changes in Response to Other Problems — if the discharger determines that there is significant physical evidence of a release, as described in §20385(a)(3), or that the detection monitoring program does not satisfy the requirements of this section, the discharger shall:

(1) notify the RWQCB by certified mail within 7 days of such determination; and

(2) within 90 days of such determination, submit an amended report of waste discharge to make any appropriate changes to the program.

(m) Changes By RWQCB — Any time the RWQCB determines that the detection monitoring program does not satisfy the requirements of this section the RWQCB shall send written notification of such determination to the discharger by certified mail, return receipt requested; the discharger shall, within 90 days after receipt of such notification by the RWQCB, submit an amended report of waste discharge to make any appropriate changes to the program.
20425. SWRCB - Evaluation Monitoring Program. (C15: §2550.9)

(a)(1) General — A discharger required pursuant to §20385 to establish an evaluation monitoring program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(2) Standards — The evaluation monitoring program shall be used to assess the nature and extent of the release from the Unit and to design a corrective action program meeting the requirements of §20430.

(b) 90 Days To Delineate Release — The discharger shall collect and analyze all data necessary to assess the nature and extent of the release from the Unit. This assessment shall include a determination of the spatial distribution and concentration of each COC throughout the zone affected by the release. The discharger shall complete and submit this assessment within 90 days of establishing an evaluation monitoring program. For MSW landfills, the discharger shall comply with the additional notification and monitoring system requirements incorporated by reference into SWRCB Resolution No. 93-62, regarding notification and monitoring relative to offsite or potential off-site migration of waste constituents [see §§258.55(g)(1)(ii & iii) of 40CFR258].

(c) 90 Days to Update EFS — Based on the data collected pursuant to .(b) and .(e), the discharger shall update the engineering feasibility study for corrective action required pursuant to §20420(k)(6). The discharger shall submit this updated engineering feasibility study to the RWQCB within 90 days of establishing an evaluation monitoring program.

(d) 90 Days to Amend ROWD — Based on the data collected pursuant to .(b) and on the engineering feasibility study submitted pursuant to .(e), the discharger shall submit an amended report of waste discharge to establish a corrective action program meeting the requirements of §20430. The discharger shall submit this report to the RWQCB within 90 days of establishing an evaluation monitoring program.

(1) MSW Landfills — For MSW landfills, the discharger shall meet the additional federal notification requirements incorporated by reference by SWRCB Resolution No. 93-62 [see 40CFR258.56(d)].

(2) Minimum ROWD Update — This report shall at a minimum include the following information:

(A) Delineation of Release — a detailed assessment of the nature and extent of the release from the Unit;

(B) Water Standard — a proposed Water Standard under §20390, including any proposed CLGBs under §20400, and all data necessary to justify each such limit;

(C) Corrective Action Measures — a detailed description of proposed corrective action measures that will be taken to achieve compliance with the Water Standard proposed for a corrective action program; and

(D) Monitoring Plan — a plan for a water quality monitoring program that will demonstrate the effectiveness of the proposed corrective action.

(3) Coordinated Landfill Gas Control — For landfills at which the information submitted under .(d) indicates that the release likely involves landfill gas, the RWQCB shall notify and shall coordinate, as appropriate, with the EA and (as appropriate) the CIWMB in developing those aspects of the corrective action program involving the design, installation, and operation of the landfill-gas control and monitoring systems at the Unit, such that the resulting gas control program satisfies the needs of all agencies concerned. [Note: the CIWMB’s gas control regulations are in Article 6, Subchapter 4, Chapter 3 (§20920 et seq.)]

(e) Ongoing Monitoring — In conjunction with the assessment conducted pursuant to .(b), and while awaiting final approval of the amended report of waste discharge, submitted pursuant to .(d), the discharger shall monitor ground water, surface water, and the unsaturated zone to evaluate changes in water quality resulting from the release from the Unit. In conducting this monitoring, the discharger shall comply with the following requirements:
(1) Notification — notify the RWQCB by certified mail that the discharger intends to make a demonstration pursuant to this subsection;

(2) Submit Demonstration Report — submit a report to the RWQCB that demonstrates that a source other than the Unit caused the evidence of a release or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone;

(3) Submit Amended ROWD — submit to the RWQCB an amended report of waste discharge to reinstitute a detection monitoring program for the Unit. This report shall propose all appropriate changes to the monitoring program; and

(4) Continue EMP Monitoring — continue to monitor in accordance with the evaluation monitoring program established pursuant to this section.

(g) Interim CAMs — The RWQCB shall require interim corrective action measures where necessary to protect human health or the environment.

(h) Discharger-Initiated EMP Changes — If the discharger determines that the evaluation monitoring program does not satisfy the requirements of this section, the discharger shall, within 90 days, submit an amended report of waste discharge to make any appropriate changes to the program.

(i) RWQCB-Initiated EMP Changes — Any time the RWQCB determines that the evaluation monitoring program does not satisfy the requirements of this section, the RWQCB shall send written notification of such determination to the discharger by certified mail, return receipt requested. The discharger shall, within 90 days of such notification by the RWQCB, submit an amended report of waste discharge to make appropriate changes to the program.


.20430. SWRCB - Corrective Action Program. (C15: §2550.10)

(a) General — A discharger required pursuant to §20385 to establish a corrective action program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(b) Standards — The discharger shall take corrective action to achieve the following goals: to remediate releases from the Unit; to ensure that the discharger achieves compliance with the Water Standard adopted under §20390 for that Unit. The RWQCB shall specify the Water Standard for corrective action [including any concentration limits greater than background, under §20400(c-g)] in the WDRs.

(c) Scope of Actions — The discharger shall implement corrective action measures that ensure that COCs achieve their respective concentration limits at all Monitoring Points and throughout the zone affected by the release, including any portions thereof that extend beyond the facility boundary, by removing the waste constituents or treating them in place. The discharger shall take other action approved by the RWQCB to prevent noncompliance with those limits due to a continued or subsequent release from the Unit, including but not limited to, source control. The WDRs shall specify the specific measures that will be taken.

(d) Monitoring — In conjunction with the corrective action measures, the discharger shall establish and implement a water quality monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program can be based on the requirements for an evaluation monitoring program (under §20425), and shall be effective in determining compliance with the Water Standard (under §20390) and in determining the success of the corrective action measures pursuant to .(c).

(e) Compliance Schedule — Corrective action measures taken pursuant to this section shall be initiated and completed by the discharger within a period of time specified by the RWQCB in the WDRs.

(f) Terminating Measures — Corrective action measures taken pursuant to .(c) (e.g., pumping and treatment of ground water) may be terminated when the discharger demonstrates to the satisfaction of the RWQCB that the
concentrations of all COCs are reduced to levels below their respective concentration limits throughout the entire zone affected by the release.

(g) **Demonstrating Completion of CAP** — After suspending the corrective action measures, pursuant to (f), the Unit shall implement the remaining portions of the Corrective Action Program until an approved Detection Monitoring Program meeting the requirements of §20420 has been incorporated into WDRs and until the discharger demonstrates to the satisfaction of the RWQCB that the Unit is in compliance with the Water Standard (under §20390). If the Unit is an MSW landfill, then this demonstration shall meet the federal requirements incorporated by reference in SWRCB Resolution No. 93-62 [see §258.58(c) of 40CFR258], in lieu of meeting the requirements of (g)(1 & 2). For all other Units, this demonstration shall be based on the following criteria and requirements:

1. the concentration of each COC in each sample from each Monitoring Point in the Corrective Action Program for the Unit must have remained at or below its respective concentration limit during a proof period of at least one year, beginning immediately after the suspension of corrective action measures; and

2. the individual sampling events for each Monitoring Point must have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per Monitoring Point.

(h) **Semi-Annual Progress Reports** — The discharger shall report, in writing, to the RWQCB on the effectiveness of the corrective action program. The discharger shall submit these reports at least semi-annually. More frequent reporting shall be required by the RWQCB as necessary to ensure the protection of human health or the environment.

(i) **Discharger-Initiated CAP Changes** — If the discharger determines that the corrective action program does not satisfy the provisions of this section, the discharger shall, within 90 days of making the determination, submit an amended report of waste discharge to make appropriate changes to the program.

(j) **RWQCB-Initiated CAP Changes** — Any time the RWQCB determines that the corrective action program does not satisfy the requirements of this section, the discharger shall, within 90 days of receiving written notification of such determination by the RWQCB, submit an amended report of waste discharge to make appropriate changes to the program.

**Note:** Authority cited: Section 1058, Water Code. Reference: Sections 13172, 13263, 13267, and 13304, Water Code; Section 43103, Public Resources Code.

20435. **SWRCB - Unsaturated Zone Monitoring and Response Provisions for Land Treatment Units (LTUs).** (C15: §2550.11)

(a) **General** — A discharger required pursuant to the provisions of this article to conduct unsaturated zone monitoring at a land treatment unit (LTU) shall comply with the unsaturated zone monitoring and response provisions of this section in conjunction with all other unsaturated zone monitoring and response provisions of this article.

(b) **Monitor Below Zone** — The discharger shall monitor the soil and soil pore liquid to determine whether COCs migrate out of the treatment zone.

(c) **Mon. Pars. & COCs** — The RWQCB shall specify the Monitoring Parameters and Constituents of Concern to be monitored in the WDRs. The Monitoring Parameters to be monitored are those specified pursuant to §20420(e) for detection monitoring and §20425(e)(2) for evaluation monitoring. The COCs to be monitored are those specified in the Water Standard specified under §20390 for each monitoring and response program. The COCs to be monitored shall include the constituents, including hazardous constituents, that must be degraded, transformed, or immobilized in the treatment zone of the LTU.

(d) [Reserved.]

(e) **Monitoring Below Treatment Zone** — The discharger shall install an unsaturated zone monitoring system that includes soil monitoring using soil cores and soil pore liquid monitoring using appropriate devices such as
lysimeters capable of acquiring soil pore liquid samples. The unsaturated zone monitoring system shall consist of a sufficient number of sampling points at appropriate locations and depths to yield samples that:

(1) represent the quality of background soil pore liquid quality and the chemical makeup of soil that has not been affected by a release from the treatment zone; and

(2) indicate the quality of soil pore liquid and the chemical makeup of the soil below the treatment zone.

(e) Background — The discharger shall establish a background value for each monitoring parameter and each COC to be monitored under §20415(e)(2). The discharger shall propose, for approval by the RWQCB, the background values for each Monitoring Parameter and each COC or the procedures to be used to calculate the background values according to the provisions of §20415(e)(10). The RWQCB shall specify the background values or procedures in WDRs according to §20415(e)(10).

(f) Background Plot — Background soil values may be based on a one time sampling at a background plot having characteristics similar to those of the treatment zone. For new land treatment units, background soil values shall include data from sampling at the proposed plot for the unit.

(g) Initial Background Data — Background soil pore liquid values shall be based on at least quarterly sampling for one year at a background plot having characteristics similar to those of the treatment zone. For new land treatment units, background soil pore liquid values shall include data from sampling at the proposed plot for the unit.

(h) Data Format — The discharger shall express all background values in a form necessary for the determination of “measurably significant” (see §20164) increases pursuant to §20415(e)(2).

(i) Performance Standard — In taking samples used in the determination of all background values, the discharger shall use an unsaturated zone monitoring system that complies with §20415(e)(1).

(j) Timing & Frequency — The discharger shall conduct soil monitoring and soil pore liquid monitoring immediately below the treatment zone. The RWQCB shall specify the frequency and timing of soil and soil pore liquid monitoring in the WDRs after considering all other monitoring provisions of this article, the frequency, timing, and rate of waste application, the soil hydraulic conductivity, and the maximum anticipated rate of migration. The discharger shall express the results of soil and soil pore liquid monitoring in a form necessary for the determination of “measurably significant” (see §20164) increases pursuant to §20415(e)(2).

(k) Propose Procedures — The discharger shall propose, for approval by the RWQCB, consistent sampling and analysis procedures that are designed to ensure sampling results that provide a reliable indication of soil pore liquid quality and the chemical makeup of the soil below the treatment zone. At a minimum, the discharger shall implement the approved procedures and techniques for:

(1) sample collection;

(2) sample preservation and shipment;

(3) analytical procedures; and

(4) chain of custody control.

(l) Testing — The discharger shall determine whether there is a “measurably significant” (see §20164) increase below the treatment zone using a statistical method that provides reasonable confidence that migration from the treatment zone will be identified. The discharger shall propose each statistical method in accordance with the provisions of this subsection and pursuant to the provisions of §20415(e)(7). The RWQCB shall specify each statistical method pursuant to §20415(e)(7) that the RWQCB finds:

(1) is appropriate for the distribution of the data used to establish background values; and

(2) provides a reasonable balance between the probability of falsely identifying migration from the treatment zone and the probability of failing to identify real migration from the treatment zone.

(m) Coordinate w/DMP Sampling — The discharger shall determine whether there is a “measurably significant” (see §20164) change over background values for each Monitoring Parameter [or, on a five-yearly basis...
under §20420(g), for each COC) to be monitored below the treatment zone each time the discharger conducts soil monitoring and soil pore liquid monitoring under (k).

(o) Data Analysis — In determining whether a “measurably significant” (see §20164) increase has occurred, the discharger shall compare the value of each parameter or constituent, using data obtained pursuant to (n), to the background value for that parameter or constituent by using an appropriate statistical procedure specified in the WDRs pursuant to this section.

(p) Timing of Data Analysis — The discharger shall determine whether there has been a “measurably significant” (see §20164) increase below the treatment zone within a reasonable time period after completion of sampling. The RWQCB shall specify this time period in the WDRs after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of soil and soil pore liquid samples.

(q) Discovery of a Release — If the discharger determines pursuant to (n), that there has been a “measurably significant” (see §20164) increase in the value of a hazardous constituent below the treatment zone the discharger shall:

1. report to the RWQCB describing the full extent of the discharger's findings, including the identification of all constituents that have shown a “measurably significant” (see §20164) increase, within 72 hours of making such a determination; and

2. submit written notification of this finding to the RWQCB within seven days of making such a determination.

(r) Release Response Options — Upon receiving notice pursuant to (q) or upon the independent confirmation by the RWQCB, the RWQCB shall order the discharger to cease operating the LTU. The discharger shall not resume operating the LTU and shall close the LTU unless one of the following actions is taken:

1. Cleanup, and Change Practices — the discharger completes appropriate removal or remedial actions to the satisfaction of the RWQCB and the discharger submits to the RWQCB and the RWQCB approves, an amended report of waste discharge to modify the operating practices at the unit to maximize the success of degradation, immobilization, or transformation processes in the treatment zone; or

2. Cleanup, Line Unit, and Change Practices — the discharger completes appropriate removal or remedial actions, submits to the RWQCB and the RWQCB approves, an amended report of waste discharge to modify the operating practices at the unit to maximize the success of degradation, immobilization, or transformation processes in the treatment zone, and equips the land treatment unit with liners, and a leachate collection and removal system that satisfy the provisions of §20330 and §20340.

(s) Schedule of Compliance — All actions taken by a discharger pursuant to (r)(1 or 2) shall be completed within a time period specified by the RWQCB, which shall not exceed 18 months after the RWQCB receives notice pursuant to (q)(1). If the actions are not completed within this time period, the LTU shall be closed, unless granted an extension by the RWQCB due to exceptional circumstances beyond the control of the discharger.

(t) Optional Demonstration — If the discharger determines pursuant to (n) that there is a “measurably significant” (see §20164) increase of hazardous constituents below the treatment zone, the discharger may demonstrate that the increase resulted from an error in sampling, analysis, or evaluation. While the discharger may make a demonstration pursuant to this subsection in addition to or in lieu of the requirements of (r)(1 or 2), the discharger is not relieved of the requirements of (r and s) unless the demonstration made pursuant to this subsection successfully shows that the increase resulted from an error in sampling, analysis, or evaluation. In making a demonstration pursuant to this subsection, the discharger shall:

1. Notification — notify the RWQCB of this finding in writing within seven days of determining a "measurably significant" (see §20164) increase beneath the treatment zone that the discharger intends to make a demonstration pursuant to this subsection;

2. Demonstration Submittal Deadline — within 90 days of such determination, submit a report to the RWQCB demonstrating that the increase resulted from error in sampling, analysis, or evaluation;
(3) Amended ROWD Submittal Deadline — within 90 days of such determination, submit to the RWQCB an amended report of waste discharge to make any appropriate changes to the unsaturated zone monitoring program for the LTU; and

(4) Continue Monitoring — continue to monitor in accordance with the unsaturated zone monitoring program established pursuant to this section.


Article 2. [§20480–§20499 Reserved by SWRCB]

Subchapter 4. Criteria for Landfills and Disposal Sites

The criteria promulgated by the CIWMB within Articles 1, 3, and 4 of this Subchapter, apply to solid waste landfills, but may be applied to disposal sites as required by the EA.

Article 1. CIWMB - Operating Criteria

20510. CIWMB - Disposal Site Records. (T14§17258.29, 17636, 17637, 17638, 17639)

(a) Each site operator shall maintain records of weights or volumes accepted in a form and manner approved by the EA. Such records shall be submitted to the EA upon request, accurate to within 10 percent and adequate for overall planning purposes and forecasting the rate of site filling.

(b) Each site operator shall maintain records of excavations which may affect the safe and proper operation of the site or cause damage to adjoining properties.

(c) Each site operator shall maintain a daily log book or file of the following information: fires, landsides, earthquake damage, unusual and sudden settlement, injury and property damage accidents, explosions, receipt or rejection of unpermitted wastes, flooding, and other unusual occurrences.

(d) Each site operator shall maintain a record of personnel training as required in §20610.

(e) Each site operator shall maintain a copy of written notification to the EA, local health agency, and fire authority of names, addresses and telephone numbers of the operator or responsible party of the site as required in §20615.

(f) Disposal site records, including MSWLF unit records, shall be available for inspection by authorized representatives of the EA, the local health agency and the CIWMB during normal business hours and retained near the site in an operating record or in an alternative location approved by the EA.


20515. CIWMB - MSWLF Unit Records. (T14§17258.29, §18257)

(a) The owner or operator of a MSWLF unit must record the following information as it becomes available:

(1) Any location restriction demonstration required under §20270;

(2) Inspection records, training procedures, and notification procedures required in §20870;

(3) Gas monitoring results from monitoring and any remediation plans required by §20919 of this Subchapter;

(4) Closure and postclosure maintenance plans as required by §21780, notice of intent to close the unit as described in §21135, notice of certification of closure as required by §21880, deed notation as required by §21170, demonstration of release from postclosure maintenance required by §21180, and any gas monitoring, testing, or analytical data as required by 40 CFR §258.61; and
(5) Any cost estimates and financial assurance documentation required by §§22221, 22226, 21820, and 21840.

(6) Any information demonstrating compliance with the small community exemption as required by 40 CFR section 258.1(f)(2).

(b) The owner/operator must notify the EA when the documents from (a) of this section have been placed in or added to the operating record, unless an alternative frequency is approved as specified in (c) and all information contained in the operating record must be furnished upon request to the EA.

(c) The EA may set alternative schedules for recordkeeping and notification requirements as specified in (a) and (b) of this section, except for the notification requirements in §20270.


.20517. CIWMB - Documentation of Enforcement Agency (EA) Approvals, Determinations and Requirements. (new)

Approvals, determinations and other requirements the EA is authorized to make under this Subchapter shall be documented in writing to the operator and placed in the operating record by the operator.


.20520. CIWMB - Signs. (T14:§17656,17657)

(a) Each point of access from a public road shall be posted with an easily visible sign indicating the facility name, and other pertinent information as required by the EA.

(b) If the site is open to the public, there shall be an easily visible sign at the primary entrance of the site indicating the name of the site operator, the operator's telephone number, and, hours of operation; an easily visible sign at an appropriate point shall indicate the schedule of charges and the general types of materials which either (1) WILL be accepted or (2) WILL NOT be accepted.

(c) If the site is open to the public, there shall be easily visible road signs and/or traffic control measures which direct traffic to the active face and other areas where wastes or recyclable materials will be deposited.

(d) Additional signs and/or measures may be required at a disposal site by the EA to protect personnel and public health and safety.


.20530. CIWMB - Site Security. (T14:§17658)

The site shall be designed to discourage unauthorized access by persons and vehicles by using a perimeter barrier or topographic constraints. Areas within the site where open storage or ponding of hazardous materials occurs shall be separately fenced or otherwise secured as determined by the EA. The EA may also require that other areas of the site be fenced to create an appropriate level of security.

.20540. CIWMB - Roads. (T14:§17659,17660)

Roads within the permitted facility boundary shall be designed to minimize the generation of dust and the tracking of material onto adjacent public roads. Such roads shall be kept in safe condition and maintained such that vehicle access and unloading can be conducted during inclement weather.


.20550. CIWMB - Sanitary Facilities. (T14:§17666)

Sanitary facilities, consisting of an adequate number of toilets and handwashing facilities, shall be available to personnel at or in the immediate vicinity of the site as approved by the EA.


.20560. CIWMB - Drinking Water Supply. (T14:§17667)

Safe and adequate drinking water for the site personnel shall be available.


.20570. CIWMB - Communications Facilities. (T14:§17668)

Each site shall have communication facilities available to site personnel to allow quick response to emergencies.


.20580. CIWMB - Lighting. (T14:§17669)

Where operations are conducted during hours of darkness, the site and/or equipment shall be equipped with adequate lighting as approved by the enforcement agency to ensure safety and to monitor the effectiveness of operations.


.20590. CIWMB - Personnel Health and Safety. (T14:§17670)

Operating and maintenance personnel shall wear and use appropriate safety equipment as required by the EA.


.20610. CIWMB - Training. (T14:§17672)

Personnel assigned to operate the site shall be adequately trained in subjects pertinent to the site operation and maintenance, including requirements of this chapter, hazardous materials recognition and screening, and heavy equipment operations, with emphasis on safety, health, environmental controls and emergency procedures. A record of such training shall be placed in the operating record.

20615. CIWMB - Supervision. (T14:§17671, 17673)
The site operator shall provide adequate supervision of a sufficient number of qualified personnel to ensure proper operation of the site in compliance with all applicable laws, regulations, permit conditions and other requirements. The operator shall notify the enforcement agency and local health agency in writing of the names, addresses, and telephone number of the operator or responsible party. A copy of the written notification shall be placed in the operating record.

20620. CIWMB - Site Attendant. (T14:§17674)
Any disposal site open to the public shall have an attendant present during public operating hours or the site shall be inspected by the operator on a regularly scheduled basis, as determined by the enforcement agency.

20630. CIWMB - Confined Unloading. (T14:§17676)
Unloading of solid wastes shall be confined to as small an area as possible to accommodate the number of vehicles using the area without resulting in traffic, personnel, or public safety hazards. Waste materials shall normally be deposited at the toe of the fill, or as otherwise approved by the enforcement agency.

20640. CIWMB - Spreading and Compacting. (T14:§17677)
Solid waste shall be spread and compacted in layers with repeated passages of the landfill equipment to minimize voids within the cell and maximize compaction. The loose layer shall not exceed a depth of approximately two feet before compaction. Spreading and compacting shall be accomplished as rapidly as practicable, unless otherwise approved by the enforcement agency.

20650. CIWMB - Grading of Fill Surfaces. (T14:§17710)
Covered surfaces of the disposal area shall be graded to promote lateral runoff of precipitation and to prevent ponding. Grades shall be established of sufficient slopes to account for future settlement of the fill surface. Other effective maintenance methods may be allowed by the enforcement agency.

20660. CIWMB - Stockpiling. (T14:§17680)
Cover material or native material unsuitable for cover, stockpiled on the site for use or removal, shall be placed so as not to cause problems or interfere with unloading, spreading, compacting, access, safety, drainage, or other operations.
Article 2. CIWMB - Daily and Intermediate Cover

20670. CIWMB - Availability of Cover Material. [T14:§17681]

A sufficient quantity of cover material of a suitable quality to meet the requirements of this Subchapter shall be available. If on-site sources of cover material are insufficient, substantiation must be shown to the EA that an adequate supply of cover material will be provided.


20680. CIWMB - Daily Cover. [T14:§17682, 17258.21]

(a) Except as provided in §(b) and §20690, or otherwise specified in 40 CFR Part 258, the owners or operators of all municipal solid waste landfill units shall cover disposed solid waste with a minimum of six inches of compacted earthen material at the end of each operating day, or at more frequent intervals if necessary, to control vectors, fires, odors, blowing litter, and scavenging. For the purposes of this section, the operating day shall be defined as the hours of operation specified in the solid waste facility permit, and may extend for more than 24 hours if operations are continuous.

(b) The EA, with concurrence by the CIWMB, may grant a temporary waiver from the requirements of §(a) if the owner or operator demonstrates that there are extreme seasonal climatic conditions that make meeting such requirements impractical.

(c) Earthen material or alternative cover materials of alternative thickness shall be placed over all surfaces of disposed solid waste for other than municipal solid waste landfill units, as required by the EA to control vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment. This requirement shall also apply to municipal solid waste landfills which qualify for a delay in the general compliance date or additional flexibility as specified in 40 CFR Part 258.

(d) For the purposes of this section, earthen material shall include contaminated soil as defined in Title 14, California Code of Regulations, §17361(b), and soil with contaminants other than petroleum hydrocarbons which has been approved for use as landfill daily cover by the RWQCB, and any other governmental agencies from which approval is required, such as the Department of Toxic Substances Control and Air Pollution Control District or Air Quality Management District.

(e) For waste classification, composition, and liquid percolation requirements of daily cover, refer to the SWRCB requirements set forth in §20705 of this article.


§ 20690. CIWMB - Alternative Daily Cover. (T14:§17682, 17258.21(b))

(a) General Requirements

(1) Alternative materials of alternative thickness for daily cover (other than at least six inches of earthen material) for municipal solid waste landfill units may be approved by the EA with concurrence by the CIWMB, if the owner or operator demonstrates that the alternative material and thickness control vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

(2) Alternative daily cover alone, or in combination with compacted earthen material, shall be placed over the entire working face at the end of each operating day or at more frequent intervals to control vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment. For the purposes of this section, the operating day shall be defined as the hours of operation specified in the solid waste facility permit, and may extend for more than 24 hours if operations are continuous.

(3) Should the application of alternative daily cover become impracticable or contribute to conditions hazardous to public health and safety and the environment, the owner or operator shall terminate such use and
revert to the use of compacted earthen cover material in accordance with §20680. For the purposes of this section, impracticable conditions are those which make placement of alternative daily cover difficult due to adverse climatic or other conditions such that the performance requirements of ¶(a)(2) cannot be met.

(4) The owner or operator shall place compacted earthen material over the entire working face at the end of any operating day preceding a period of time greater than 24 hours when the facility is closed, unless procedures as required by the EA are in place to ensure that the requirements of ¶(a)(2) and (a)(3) are met. A stockpile of earthen cover material and required equipment shall be available to ensure a corrective response to violation of ¶(a)(2) and (a)(3).

(5) The owner or operator shall maintain a record of waste derived alternative daily cover in accordance with Title 14, California Code of Regulations, §18800 et. seq., with the addition of type and quantity of each waste derived alternative daily cover material applied as cover. The records shall be available for inspection by authorized representatives of the EA, the local health agency, and the CIWMB during normal business hours and retained in the operating record near the site or in an alternative location approved by the EA.

(6) For waste classification, composition, and liquid percolation requirements of alternative daily cover, refer to the SWRCB requirements set forth in §20705.

(7) Waste derived materials used as alternative daily cover shall be restricted to quantities no more than necessary to meet the performance requirements of ¶(a)(2), or as specified in subdivision (b) of this section.

(8) Compost, co-compost, and chemically fixed sewage sludge, that meet the performance standards for cover material, shall be limited to up to 25 percent of landfill cover materials or landfill cover extenders as required under Public Resources Code (PRC) 42245. For the purposes of this section, “chemically fixed sewage sludge” means solid and semisolid residue generated during the treatment of domestic sewage. The 25 percent limit shall apply on a quarterly basis to the total daily and intermediate cover or cover extender use. For the purposes of this section, landfill cover extenders shall mean compost, co-compost, or chemically fixed sewage sludge blended or mixed with soil.

(9) Storage and handling of waste derived materials at the landfill for use as alternative daily cover shall be conducted in a manner to protect public health and safety and the environment, and control vectors, fires, odors, and nuisances.

(10) The EA shall apply this section to disposal facilities other than municipal solid waste landfill units as necessary to control vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment. This requirement shall also apply to municipal solid waste landfills which qualify for a delay in the general compliance date or additional flexibility as specified in 40 CFR Part 238.

(b) Specific Requirements

Proposed uses of alternative daily cover materials not specified in ¶(b)(1) through (10) shall be subject to site specific demonstration projects approved by the EA with concurrence by the CIWMB to establish suitability as daily cover. Site specific demonstration projects are not required for the following materials used as specified and in accordance with subdivision (a) of this section.

(1) Geosynthetic Fabric or Panel Products (Blankets)

(A) Geosynthetic blanket products shall be removed from the waste and the waste shall be covered with new waste or approved cover materials within 24 hours of product placement, unless the product is intended to be nonreusable, or has been approved by the EA for continuous use beyond 24 hours.

(2) Foam Products

(A) Foam products shall not be applied when there is precipitation or when there is a local forecast of greater than 40% chance of precipitation within 8 hours of application time in the vicinity of the landfill.

(B) Foam products shall be covered with waste or other approved cover materials within 72 hours of application, unless a shorter time period is required by the EA to meet the requirements of ¶(a)(2) and (a)(3) of this section.
(3) Processed Green Material
   (A) Processed green material shall be green material as defined in Title 14, California Code of Regulations, §17852(a) with the exclusion of manure. Processed green material may include varying proportions of wood waste from urban and other sources and shall be ground, shredded, screened or otherwise processed in a manner to provide a compacted material free of open voids when applied to meet the performance requirements as alternative daily cover.

   (B) Processed green material shall be restricted to a minimum compacted thickness of 6 inches and average compacted thickness of less than or equal to 12 inches.

   (C) Processed green material placed as cover shall not be exposed for greater than 21 days.

(4) Sludge and Sludge-Derived Materials
   (A) Public contact with sludge or sludge-derived materials, either alone or blended with soil, ash, processed green material, or stabilization agents such as lime, lime kiln dust, or cement kiln dust, shall be prohibited. This prohibition shall apply to staging, processing, tipping, and cover placement areas.

   (B) Sludge or sludge-derived materials, either alone or blended with soil, processed green material, ash, or stabilization agents such as lime, lime kiln dust, or cement kiln dust, shall form a compacted material which can be placed without forming open voids or causing material to be tracked off the working face area.

(5) Ash and Cement Kiln Dust Materials
   (A) Ash and Cement Kiln Dust, either alone or blended with earthen material or stabilization agents, shall form a compacted material which can be placed without forming open voids or causing material to be tracked off the working face area. For the purposes of this section ash means the nonhazardous residue from the combustion of material or the hazardous residue which may be managed as a nonhazardous waste in accordance with Title 22 California Code of Regulations sections 66260.200(f) or 66260.210.

   (B) Ash and Cement Kiln Dust, either alone or blended with earthen material or stabilization agents shall be used as alternative daily cover in a manner to minimize the creation of dust.

   (C) Ash and Cement Kiln Dust, either alone or blended with earthen material or stabilization agents, shall be restricted to a minimum compacted thickness of 6 inches and average compacted thickness of less than 18 inches.

(6) Treated Auto Shredder Waste
   (A) Auto shredder waste shall be treated pursuant Title 22, California Code of Regulations, section 66268.106(a)(1).

   (B) Treated auto shredder waste used for alternative daily cover shall be restricted to a minimum compacted thickness of 6 inches and average compacted thickness of less than 24 inches.

(7) Contaminated Sediment, Dredge Spills, Foundry Sands, Energy Resource Exploration and Production Wastes
   (A) Contaminated sediment, dewatered dredge spoils, foundry sands, or processed energy resource exploration and production wastes shall be restricted to a minimum compacted thickness of 6 inches and average compacted thickness of less than 18 inches. Such materials shall form a compacted material which can be placed without forming open voids or causing material to be tracked off the working face area.

(8) Compost Materials
   (A) Except as provided in 1(b)(B), of this section, compost shall meet the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7.

   (B) Public contact shall be precluded from cover staging, processing, tipping, and placement areas for compost which does not meet the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7.

(9) Construction and Demolition Wastes
   (A) Construction and demolition wastes shall be restricted to crushed, ground, or screened materials alone or mixed with soil to provide a compacted material free of open voids.
(B) Construction and demolition wastes shall be restricted to a minimum compacted thickness of 6 inches and average compacted thickness of less than 18 inches.

(10) Shredded Tires
(A) Shredded tires used as daily cover alone or mixed with soil shall be shredded such that 50% by volume is smaller than 6 inches in length and no individual pieces are greater than 12 inches in length.

(B) Shredded tires used as alternative daily cover without admixed soil shall not be applied when there is precipitation or when there is a local forecast of greater than 40% chance of precipitation within 8 hours of application time in the vicinity of the landfill.


20695. CIWMB - Cover Performance Standards. [T14:§17683]
The EA may require the following cover performance standards if necessary to control vectors, fires, odors, and blowing litter and to evaluate the suitability of alternative daily or intermediate cover:

(a) Vectors
(1) Threshold Values — The following shall constitute threshold values for vector populations:

(A) Flies—A fly grill survey value of six (6) or more domestic flies, or observations of domestic flies in the "crawler" stage (newly emerged adults prior to wings becoming functional) at a density of three (3) or more per square yard of surface area at any location on the disposal area. Domestic flies are considered to be those species in the Families: Muscidae (including Anthomyiidae), Calliphoridae, Sarcophagidae, and Drosophilidae.

(B) Domestic Rats — The trapping of one or more domestic rats anywhere on the disposal site. Domestic rats are considered to be any species in the genus Rattus.

(C) Field Rodents — Observation of five (5) or more field rodents feeding on the active face of the disposal site. Field rodents are considered to be any species in the Family Sciuridae.

(D) Mosquitoes — The observation of any immature mosquito stages from water holding waste materials on the disposal site.

(E) Wasps, cockroaches, etc. — The observation of excessive populations utilizing accepted norms.

(2) Inspection Practices
(A) Schedule — Fly grill surveys shall be conducted on each disposal site a minimum of once per week. Sampling to determine the species composition of the fly population shall be conducted a minimum of once per month. Rat trapping surveys shall be conducted at least once each month. Observations for mosquitoes, wasps, cockroaches, "crawler" flies or other types of vectors shall be made during each inspection of the disposal site. The EA may approve alternative inspection schedules or cease inspections if previous inspections or other observations indicate no further threat to public health and safety.

(B) Procedure — Ten (10) fly grill counts shall be made over appropriate attractants on the active face of the disposal site during each inspection utilizing accepted practices to count and record the flies. The five (5) highest counts shall be averaged to obtain the value for that inspection. In sampling to provide qualitative data for the fly species composition on a disposal site, any of the following or other acceptable method for sampling adult flies shall be observed:

- bait traps, exposed for at least a continuous 24-hour period at separate locations, or
- sticky tapes, exposed for a continuous 24-hour period at separate locations, or
- utilization of a standard insect net on the active working face, or
- other approved method to provide a representative sample.
For uniformity of information, one of the approved methods shall be selected for use on a continuing basis at each disposal site.

A minimum of two (2) domestic rat trap lines each containing twenty (20) traps shall be operated for one night on each disposal site at the prescribed frequency. Traps appropriately baited, shall be set at 20-foot intervals in each trap line. One trap line shall be located on or as close to the active face as practical. The other trap line shall be located on the periphery of the site in suitable rodent habitat. On very large sites additional trap lines will be required to provide an adequate sample. Visual observations of field rodents or their signs shall be made and recorded during each inspection.

(C) Equipment — All fly surveys conducted on the active face of the disposal site shall be made with a Scudder fly grill. This device is a square grill consisting of 24 slats, each 3' x 3/4" x 1/4" placed 3/4" apart on a Z-shaped framework. Species composition of fly populations at the site shall be made with the use of fly traps, sticky tapes, an insect net, or other approved method to provide a representative sample. Snap traps or live traps, or a combination thereof, of suitable size and design shall be used to capture mature domestic rats.

(D) Records — The following information shall be recorded at a minimum during each inspection: Name of site; location; date of inspection; name of person(s) making the inspection; the time the inspection began; the time the inspection ended; temperature; wind conditions; moisture conditions; sky conditions; shade; attractants, when applicable; results of the 10 Scudder grill counts; number and species of all flies captured; number of domestic rats trapped since the previous inspection; number of field rodents observed (or signs of their presence), and the presence of any mosquitoes, wasps, cockroaches, or other types of vectors. These records shall be kept up to date and shall be submitted to the EA upon request.

(b) Fire
Burning material, or any solid waste at a temperature likely to cause fire, shall not be deposited in the fill. Said material shall initially be deposited in a separate location a sufficient distance from the fill area to prevent fires from spreading to the normal fill area. It shall then be spread in a single layer not exceeding one (1) foot in thickness and immediately covered with a sufficient amount of earth or sprayed with sufficient fire retardant to extinguish all combustion. Final disposition of the material shall not take place until the operator is certain that no further combustion will take place under any conditions.

Fires which originate within the fill shall be handled by removing all the burning material from the fill and extinguishing it as described above, or by in-situ practices approved by the EA, in consultation with the local fire authority. Excavation of burning materials shall be undertaken in a planned and controlled manner; with sufficient fire fighting equipment present to control any "flare-ups" which may occur as outside air reaches the burning materials. The EA shall be immediately notified of any fire.

(c) Litter
Accumulation or offsite migration of litter in quantities that create a nuisance, injury to the public and personnel, or cause other problems, shall be prevented.

(d) Alternative Methods
Alternative cover performance standards in lieu of (a) through (c) of this section may be applied by the EA with concurrence by the CIWMB.


20700. CIWMB - Intermediate Cover. (T14:§17684)
(a) Compacted earthen material at least twelve (12) inches shall be placed on all surfaces of the fill where no additional solid waste will be deposited within 180 days to control vectors, fires, odors, blowing litter, and scavenging.

(b) Alternative materials of alternative thickness (other than at least twelve inches of earthen material) for intermediate cover may be approved by the EA with concurrence by the CIWMB, if the owner or operator
demonstrates that the alternative material and thickness control vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

(c) For waste classification, composition, and liquid percolation requirements of intermediate cover and alternative intermediate cover, refer to the SWRCB requirements set forth in §20705 of this article.

(d) Proposed use of alternative intermediate cover shall be subject to site specific demonstration to establish suitability as intermediate cover. Demonstration projects shall be approved by the EA with concurrence by the CIWMB.


§20701. CIWMB - Slope Stability of Daily and Intermediate Cover. (T14:§17678) - [Reserved]

20705. SWRCB - Standards for Daily and Intermediate (Interim) Cover. (C15: §2544)
[Note: This section applies in conjunction with CIWMB sections 20680-20701 and addresses cover issues prior to the installation of the final cover. Readers interested in the SWRCB-promulgated requirements for final cover will find them at §21090.]

(a) Daily & Intermediate — Interim cover at landfills is “daily cover” and “intermediate cover” as defined by the CIWMB (see §20164).

(b) Minimize Percolation — Interim cover over wastes discharged to a landfill shall be designed and constructed to minimize percolation of liquids through wastes.

(c) For Class II Waste Piles — Cover may be required by RWQCBs for Class II waste piles.

(d) [Reserved]

(e) Limitations On Cover Materials — Except for reusable covers that are never incorporated into the Unit, daily and intermediate cover shall only consist of materials:

(1) Match Unit Classification — which meet the classification criteria for wastes that can be discharged to that landfill. Therefore, a material that would be classified as a designated waste cannot be utilized for daily or intermediate cover at a Class III landfill unless that material is approved for discharge (as a waste) to that landfill pursuant to §20200(a)(1); and

(2) Composition — whose constituents (other than water) and foreseeable breakdown byproducts, under the chemical (including biochemical) and temperature conditions which it is likely to encounter within the landfill, either:

(A) for non-composite lined portions of the Unit, are mobilizable only at concentrations which would not adversely affect beneficial uses of waters of the state, in the event of a release; or

(B) for composite-lined portions of the Unit, are listed as COCs in the Unit’s water quality protection standard (Water Standard), created pursuant to §20395.

(f) Dust Control — The requirements of §21090(a)(5) regarding the discharge of leachate, gas condensate, and other liquids to final-covered portions of the Unit also apply to the discharge of liquids to daily and intermediate cover, including discharges made for the purpose of dust control.

NOTE: Authority cited: Section 1058, Water Code; Reference: Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.
Article 3. CIWMB - Handling, Equipment and Maintenance

.20710. CIWMB - Scavenging, Salvaging, and Storage. (T14:§17686,17687,17690,17691)
(a) Scavenging is prohibited at any disposal site.

(b) Salvaging as approved by the EA shall be conducted in a planned and controlled manner and shall not interfere with other aspects of site operations, including the expeditious entry and egress of vehicles at the site.

(c) Salvaged materials generated on-site or imported shall be placed for storage in a specified, clearly identifiable area segregated from the working face. Salvaged materials shall be arranged so as to minimize risk of fire, health and safety hazard, vector harborage, or other hazard or nuisance, and be limited to a volume and storage time as approved by the enforcement agency.


.20720. CIWMB - Non-Salvageable Items. (T14:§17692)
Drugs, cosmetics, foods, beverages, hazardous chemicals, poisons, medical wastes, syringes, needles, pesticides and other materials capable of impairing public health shall not be salvaged unless approved by the EA and the local health agency.


.20730. CIWMB - Volume Reduction and Energy Recovery. (T14:§17688,17689)
Volume reduction such as incineration, baling, shredding, composting, pyrolysis, and materials and energy recovery operations as approved by the EA shall be confined to specified, clearly identifiable areas of the site. If volume reduction is conducted operations shall be done in a controlled manner as an integral part of the operation and not interfere with the proper construction and maintenance of the site or create health, safety, or environmental problems.


.20740. CIWMB - Equipment. (T14:§17693,17694)
Equipment shall be adequate in type, capacity and number, and sufficiently maintained to permit the site operation to meet requirements of these standards.


.20750. CIWMB - Site Maintenance. (T14:§17695,17696)
The operator shall implement a preventative maintenance program to monitor and promptly repair or correct deteriorated or defective conditions with respect to requirements of the CIWMB standards, and conditions established by the EA. All other aspects of the disposal site shall be kept in a state of reasonable repair.

Article 4. CIWMB - Controls

.20760. CIWMB - Nuisance Control. (T14:§17701)
Each disposal site shall be operated and maintained so as not to create a public nuisance.

.20770. CIWMB - Animal Feeding. (T14:§17702)
Feeding of solid waste to animals which will be used for human consumption is prohibited on disposal sites. Grazing of livestock away from operating areas is permitted.

.20780. CIWMB - Open Burning and Burning Wastes. (T14:§17258.24(b),17703, 17741)
(a) Open burning of solid waste, except for the infrequent burning of agricultural wastes, silvicultural wastes, landclearing debris, diseased trees, or debris from emergency clean-up operations, is prohibited at all solid waste landfills.

(b) If burning wastes are received, they shall be deposited in a safe area and extinguished. If burning wastes have been placed in an active face, they shall be immediately excavated, spread and extinguished.

.20790. CIWMB - Leachate Control. (T14:§17704,17709)
The operator shall ensure that leachate is controlled to prevent contact with the public.

.20800. CIWMB - Dust Control. (T14:§17706)
The operator shall take adequate measures to minimize the creation of dust and prevent safety hazards due to obscured visibility.

.20810. CIWMB - Vector and Bird Control. (T14:§17707)
The operator shall take adequate steps to control or prevent the propagation, harborage or attraction of flies, rodents, or other vectors and to minimize bird problems.

.20820. CIWMB - Drainage and Erosion Control. (T14:§17708,17715)
(a) The drainage system shall be designed and maintained to:

(1) ensure integrity of roads, structures, and gas monitoring and control systems;

(2) prevent safety hazards; and
(3) prevent exposure of waste.

.20830. CIWMB - Litter Control. (T14:§17711)
Litter shall be controlled, routinely collected and disposed of properly. Windblown materials shall be controlled to prevent injury to the public and personnel. Controls shall prevent the accumulation, or off-site migration, of litter in quantities that create a nuisance or cause other problems.

.20840. CIWMB - Noise Control. (T14:§17712)
Noise shall be controlled to prevent health and safety hazards to persons using the site and to nearby residents.

.20860. CIWMB - Traffic Control. (T14:§17714)
Traffic flow into, on, and out of the disposal site shall be controlled to minimize the following:
(a) interference and safety problems with traffic on adjacent public streets or roads,
(b) on-site safety hazards, and
(c) interference with site operations.

.20870. CIWMB - Hazardous Wastes. (T14:§17742,17258.20)
(a) Owners or operators of all MSWLF units must implement a program at the facility for detecting and prevented the disposal of regulated hazardous wastes as defined in 40 CFR Part 261 and polychlorinated biphenyls (PCB) wastes as defined in 40 CFR Part 761. This program must include, at a minimum:
(1) Random inspections of incoming loads unless the owner or operator takes other steps to ensure that incoming loads do not contain regulated hazardous wastes or PCB wastes;
(2) Records of any inspections;
(3) Training of facility personnel to recognize regulated hazardous wastes and PCB wastes; and
(4) Notification of the EA, the Director of the California Department of Toxic Substances Control (DTSC) or its delegated agent, and the Regional Water Quality Control Board (RWQCB), if a regulated hazardous waste or PCB waste is discovered at the facility.
(b) A site shall not accept hazardous wastes unless the site has been approved for the particular waste involved.
(c) At sites where hazardous materials are processed, precautions must be taken to eliminate or control dusts, fumes, mists, vapors or gases that may be produced in quantities and under conditions which may have harmful effects on site personnel, the general public or animals.
20880. CIWMB - Medical Waste. (ncw)
Medical waste, unless treated and deemed to be solid waste, which is regulated pursuant to the Medical Waste Management Act [Part 14 (commencing with Section 117600) of Division 104 of the Health and Safety Code], shall not be accepted for disposal at a site.

20890. CIWMB - Dead Animals. (T14:§17744)
Dead animals may be accepted if allowed by local regulations and shall be covered immediately or at a frequency approved by the EA.

20900. CIWMB - Air Criteria. [T14:§17258.24(a)]
Owners or operators of all MSWLF's must ensure that the units do not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the Administrator, United States Environmental Protection Agency, pursuant to section 110 of the Clean Air Act, as amended.

Article 5. CIWMB - Fire Control at Active and Closed Disposal Sites
§20905. CIWMB - [Reserved]

§20915. CIWMB - Subsurface Fire Control. [Reserved]

§20917. CIWMB - Scope and Applicability. (Reserved)

20918. CIWMB - Exemptions. (T14:§17783.17)
A disposal site other than a MSWLF unit, may be granted an exemption to all or any portion of the requirements of Article 6 of this Subchapter if the operator can demonstrate to the satisfaction of the EA, that there is no potential for adverse impacts on public health and safety and the environment, based upon but not limited to: the amount, nature and age of refuse; projected gas generation; and remoteness of the facility. Exemptions and alternatives shall be reviewed by the EA in conjunction with the five (5) year permit review, and based on the results, the EA may extend or terminate the exemption.

20919. CIWMB - Gas Control. (T14:§17705)
Where the enforcement agency, the local fire control authority, or the CIWMB has cause to believe a hazard or nuisance may be created by landfill decomposition gases, they shall so notify the owner. Thereafter, the site owner shall cause the site to be monitored for presence and movement of gases, and shall take necessary action to control
such gases. The site owner shall inform the operator of any actions ordered by the EA, the local fire control authority or the CIWMB concerning gas control methods. The monitoring program shall be developed pursuant to the specifications of the above agencies. The monitoring program shall not be discontinued until authorized to do so in writing by the requiring agency. Results of the monitoring shall be submitted to the appropriate agencies. If monitoring indicates methane gas movement away from the site, the owner shall, within a period of time specified by the requiring agency, construct a gas control system approved by that agency. The agency may waive this requirement if satisfactory evidence is presented indicating that adjacent properties are safe from hazard or nuisance caused by methane gas movement. The operator shall duly inform the disposal site owner of possible landfill gas problems.


20919.5. CIWMB - Explosive Gases Control. (T14:§17258.23.)

(a) Owners or operators of all MSWLF units must ensure that:

(1) The concentration of methane gas generated by the facility does not exceed 25 percent of the lower explosive limit for methane in facility structures (excluding gas control or recovery system components); and

(2) The concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.

(b) Owners or operators of all MSWLF units must implement a routine methane monitoring program to ensure that the standards of .(a) are met.

(1) The type and frequency of monitoring must be determined based on the following factors:

(i) soil conditions;

(ii) the hydrogeologic conditions surrounding the facility;

(iii) the hydraulic conditions surrounding the facility; and

(iv) the location of facility structures and property boundaries.

(2) The minimum frequency of monitoring shall be quarterly.

(c) If methane gas levels exceeding the limits specified in .(a) are detected, the owner or operator must:

(1) immediately take all necessary steps to ensure protection of human health and notify the EA;

(2) within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

(3) within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the EA that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

(4) The EA with concurrence by the CIWMB pursuant to 40 CFR 258.23(c)(4) may establish alternative schedules for demonstrating compliance with .(c)(2) and .(c)(3).

(d) For purposes of this section, "lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure.

(e) The EA shall forward notifications and approvals pursuant to §20919.5(c)(1) and (c)(3) to the CIWMB pursuant to 40 CFR 258.23(c)(1) and (c)(3).

.20920. CIWMB - Scope and Applicability for Gas Monitoring and Control Requirements During Closure and Postclosure. (T14:§17760)
   (a) Sections 20921 through 20937 set forth the performance standards and the minimum substantive requirements for landfill gas monitoring and control as it relates to proper closure, postclosure maintenance and ultimate reuse of solid waste disposal sites to assure that public health and safety and the environment are protected from pollution due to the disposal of solid waste.
   (b) Sections 20921 through 20937 apply to:
      (1) Solid waste disposal sites that did not commence complete closure prior to August 18, 1989, which was fully implemented by November 18, 1990, in accordance with all applicable requirements; and
      (2) new postclosure activities that may jeopardize the integrity of previously closed sites or pose a threat to public health and safety or the environment.
NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

.20921. CIWMB - Gas Monitoring and Control During Closure and Postclosure. (T14:§17783)
   (a) To provide for the protection of public health and safety and the environment, the operator shall ensure that landfill gases generated at a disposal site are controlled in accordance with the following requirements:
      (1) The concentration of methane gas must not exceed 1.25% by volume in air within on-site structures.
      (2) The concentration of methane gas migrating from the landfill must not exceed 5% by volume in air at the facility property boundary or an alternative boundary approved in accordance with §20925.
      (3) Trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.
   (b) The program implemented pursuant to §§20921 - 20937 shall continue for a period of thirty (30) years or until the operator receives written authorization to discontinue by the EA with concurrence by the CIWMB pursuant to 40 CFR 258.61(b). Authorization to cease gas monitoring and control shall be based on a demonstration by the operator that there is no potential for gas migration beyond the property boundary or into on-site structures. Demonstration of this proposal shall be supported by data collected and any additional studies.
   (c) The gas monitoring program required pursuant to §§20921 - 20937, shall be described as part of the preliminary and final postclosure maintenance plan.
   (d) Gas monitoring and control systems shall be modified, during the closure and postclosure maintenance period, to reflect changing on-site and adjacent land uses. Postclosure land use at the site shall not interfere with the function of gas monitoring and control systems. The operator may request a reduction of monitoring or control activities based upon the results of monitoring data collected. The request for reduction of monitoring or control activities shall be submitted in writing to the EA.
NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

§20923. CIWMB - Monitoring (T14:§17783.3)
   (a) To ensure that the conditions of §20921 are met, the operator shall implement a gas monitoring program at the disposal site in accordance with the following requirements:
      (1) the gas monitoring network shall be designed by a registered civil engineer or a certified engineering geologist, and shall ensure detection of the presence of landfill gas migrating beyond the landfill property boundary and also into on site structures; and
(2) The monitoring network shall be designed to account for the following specific site characteristics and potential migration pathways or barriers, including, but not limited to:

(A) local soil and rock conditions;
(B) hydrogeological conditions at the disposal site;
(C) locations of buildings and structures relative to the waste disposal area;
(D) adjacent land use, and inhabitable structures within 1000 feet of the disposal site property boundary;
(E) man made pathways, such as underground construction; and
(F) the nature and age of waste and its potential to generate landfill gas.

Note: Authority Cited: Sections 40902 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43201 and 43103, Public Resources Code; and Section 66796.22(d) Government Code.

History
See Title 14 for 4. points of history.

.20925. CIWMB - Perimeter Monitoring Network. (T14:§17783.5)

(a) Location
(1) Perimeter subsurface monitoring wells shall be installed around the waste deposit perimeter but not within refuse. The entire perimeter of the disposal site may not warrant the installation of monitoring wells. In this case, the operator shall demonstrate to the satisfaction of the EA that gas migration could not occur due to geologic barriers and that no inhabitable structure or other property such as agricultural lands within 1,000 feet of the property boundary are threatened by gas migration.

(2) Perimeter monitoring wells shall be located at or near the disposal site property boundary. The operator may establish an alternate boundary closer to the waste deposit area based on a knowledge of the site factors in §20923(a)(2). When compliance levels are exceeded at the alternate boundary, the operator shall install additional monitoring wells closer to the property boundary, pursuant to §20937.

(b) Spacing
(1) The lateral spacing between adjacent monitoring wells shall not exceed 1,000 feet, unless it can be established to the satisfaction of the EA, in §20923(a)(2).

(2) The spacing of monitoring wells shall be determined based upon, but not limited to: the nature of the structure to be protected and its proximity to the refuse. Wells shall be spaced to align with gas permeable structural or stratigraphic features, such as dry sand or gravel, off site or on site structures, and areas of dead or stressed vegetation that might be due to gas migration.

(3) Probe spacing shall be reduced as necessary to protect persons and structures threatened by landfill gas migration.

(c) Depth
(1) The depth of the wellbore shall equal the maximum depth of waste as measured within 1,000 feet of the monitoring point. The number and depths of monitoring probes within the wellbore shall be installed in accordance with the following criteria, except as specified in .(c)(2).

(A) a shallow probe shall be installed 5 to 10 feet below the surface;
(B) an intermediate probe shall be installed at or near half the depth of the waste;
(C) a deep probe shall be set at or near the depth of the waste;
(D) the specified depths of monitoring probes within the wellbore shall be adjusted, based on geologic data obtained during drilling, and probes shall be placed adjacent to soils which are most conductive to gas flow;
(E) All probes shall be installed above the permanent low seasonal water table, above and below perched ground water, and above bedrock; and

(F) When the depth of the waste does not exceed 30 feet, the operator may reduce the number of probes to two, with one probe located in the shallow zone as indicated above, and the other located adjacent to permeable soils at or near the depth of the waste.

(2) Exclusions or modifications to (c)(1) may be requested for certain disposal sites (i.e., filled pits, cut and trench, and canyon fills). When conditions limit the practicality or do not warrant the installation depth criteria, the operator shall propose an alternate system of equivalent probe depths. The proposal must demonstrate to the satisfaction of the EA, that probes located at these depths are sufficient to detect migrating landfill gas and provide protection to public health and safety and the environment.

(3) The EA may require an increase in the number of monitoring probes, the depth of the wellbore, or modify the depths of monitoring probes within a wellbore to ensure compliance with §20921(a). The operator is not precluded from utilizing existing gas monitoring probes of an alternate design, when the operator demonstrates to the satisfaction of the EA, that such probes have been installed in a manner that ensures the detection of landfill gas migrating from the disposal site.

(d) Monitoring Well Construction

(1) Monitoring wells shall be drilled by a licensed drilling contractor, or where in house drilling capability exists, by a drilling crew under the supervision of the design engineer or engineering geologist. Wells shall be logged during drilling by or a geologist or geotechnical engineer. Soils shall be described using the ASTM Designation: D2488 84 method for visual classification, Standard Practice for Description and Identification of Soils (Visual Manual Procedure), which is incorporated by reference. Rock units shall be described in a manner appropriate for geologic investigation.

(2) A record of each monitoring well shall be maintained by the operator and submitted to the EA upon request. The record shall include:

(A) a facility map drawn to a scale proposed by the design engineer or engineering geologist, sufficient to show the location of all monitoring wells. The well must be identified with a number that corresponds to the well log. Surface elevations at the wellheads shall be denoted on the map;

(B) well logs, including the names of the person(s) logging the hole; and

(C) an as built description, including a well detail which indicates probe material and depth, extent and type of filter pack, thickness and material used for seals, extent and material used for backfill, size and interval of perforations, and a description of any shutoff valves or covers.

(3) To isolate monitored zones within the wellbore, and prevent contamination of perched ground water and permanent ground water, the operator shall provide a minimum seal of five (5) feet of bentonite at the surface and between the monitored zones.

NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

20931. CIWMB - Structure Monitoring. (T14:§17783.7)
(a) To ensure that the requirements of §20923(a)(1) are met, the monitoring network design shall include provisions for monitoring on site structures, including but not limited to buildings, subsurface vaults, utilities or any other areas where potential gas buildup would be of concern. The proposal shall address on site structures, both adjacent to and on top of the waste deposit area.

(b) Methods for monitoring on site structures may include, but are not limited to: periodic monitoring, utilizing either permanently installed monitoring probes or gas surveys; and continuous monitoring systems.

(c) Structures located on top of the waste disposal area shall be monitored on a continuous basis. When practical, structures shall be monitored after they have been closed overnight or for the weekend to allow for an accurate assessment of gas accumulation. Areas of the structure where gas may accumulate shall be monitored and may
include, but are not limited to areas in, under, beneath and around basements, crawl spaces, floor seams or cracks, and subsurface utility connections.

NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

.20932. CIWMB - Monitored Parameters. (T14:§17783.9)
(a) All monitoring probes and on site structures shall be sampled for methane during the monitoring period. Sampling for specified trace gases may be required by the EA when there is a possibility of acute or chronic exposure due to carcinogenic or toxic compounds.
NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

.20933. CIWMB - Monitoring Frequency. (T14:§17783.11)
(a) At a minimum, quarterly monitoring is required. The EA may require more frequent monitoring based upon site specific factors in §20923(a)(2). When more frequent monitoring is necessary, the requiring agency shall notify the operator.

(b) More frequent monitoring may also be required at those locations where results of monitoring indicate that landfill gas migration is occurring or is accumulating in structures.

(c) The operator shall increase the monitoring frequency, as is necessary, to detect migrating gas and ensure compliance with §20921.
NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

.20934. CIWMB - Reporting. (T14:§17783.13)
(a) The results of gas monitoring shall be submitted to the EA within ninety (90) days of sampling, provided that compliance levels are maintained. When compliance levels are exceeded at any probe, the requirements of §20937 shall apply. The monitoring reports shall include:

1. the concentrations of the methane, as measured at each probe and within each on-site structure;
2. the concentrations of specified trace gases, if required;
3. the documentation of date, time, barometric pressure, atmospheric temperatures, general weather conditions, and probe pressures;
4. the names of sampling personnel, apparatus utilized, and a brief description of the methods used; and
5. a numbering system to correlate monitoring results to a corresponding probe location.
NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

.20937. CIWMB - Control. (T14:§17783.15)
(a) When the results of gas monitoring indicate concentrations of methane in excess of the compliance levels required by §20921(a), the operator shall:

1. Take all immediate steps necessary to protect public health and safety, and the environment.
2. Notify the EA in writing within five (5) working days of learning that compliance levels have been exceeded, and indicate what has been done or is planning to be done to resolve the problem.
3. Verify accuracy of results by reviewing the following:
   (A) probe readings;
(B) possible liquid interference;
(C) control well influence; and
(D) barometric pressure effects.

(4) Within ten (10) working days, submit to the EA a letter which describes the nature and extent of the problem, and any immediate corrective actions that need to be taken to protect public health and safety, and the environment.

(3) Construct a gas control system, designed by a registered civil or mechanical engineer, within a period of time specified by the EA. Installation of the system shall be in accordance with a design and in a manner approved for construction by the EA in coordination, if applicable, with the RWQCB.

(b) A gas control system shall be designed to:

(1) Prevent methane accumulation in on site structures.

(2) Reduce methane concentrations at monitored property boundaries to below compliance levels.

(3) Reduce trace gas concentrations.

(4) Provide for the collection and treatment and/or disposal of landfill gas condensate produced at the surface. Condensate generated from gas control systems shall not be recirculated into the landfill unless analysis of the condensate demonstrates to the satisfaction of the EA that it is acceptable to allow recirculation into landfills which have a liner and an operating leachate collection systems and the RWQCB approve such discharge pursuant to §20200(d).

(c) Subsurface gas control systems may include, but are not limited to, one or more of the following:

(1) Active perimeter or interior control systems which are designed to accommodate the maximum expected flow rate from the disposal site, and provide access for system monitoring and flow rate adjustment. The control system shall be operated to ensure that gas is controlled at a sufficient rate without overpulling, to maximize control and not production, and to ensure adequate control for compliance with §20923(a).

(2) Perimeter air injection systems which shall be installed in native soil between the refuse and the area to be protected. Injection wells shall not be located in the refuse. The system shall be designed and operated to prevent air infiltration into the landfill but maintain methane concentrations to compliance levels.

(3) Passive systems, including cutoff trenches, slurry walls, and vent trenches, when used shall be constructed with an impermeable geomembrane liner. The passive systems shall be installed to the depth of permanent low seasonal ground water or keyed into a low permeability layer below the limit of migration.

(d) When the results of monitoring in on site structures indicate levels in excess of those specified in §20923(a), the operator shall take appropriate action to mitigate the effects of landfill gas accumulation in on site structures. Gas control measures to protect structures, and public health and safety, shall include one or more of the following:

(1) Flexible membrane liners,

(2) Active collection systems,

(3) Passive collection systems designed to be upgraded to an active system,

(4) Alarms,

(5) Ignition source control,

(6) Utility collars installed within structures and outside in trenches, and

(7) Ventilation.

(e) To ensure that the gas control system is operating at optimum efficiency to control landfill gas, the operator shall provide for system monitoring and adjustment.
(f) To provide for the safe, efficient operation of the gas control system, the operator shall implement a maintenance program in accordance with the following requirements:

(1) A site specific operations and maintenance manual shall be maintained and kept current to reflect any expansion or modifications to the gas control system.

(2) An operations and maintenance manual shall provide for periodic inspections and servicing of gas control equipment.

(3) Operations and maintenance shall be recorded and the records shall be retained by the operator.

(g) Construction Quality Assurance/Quality Control

(1) The operator shall be responsible for providing inspections, as needed, to ensure the integrity of the system.

(2) Prior to construction, the designer shall obtain and review all applicable test reports, shop drawings, and manufacturer’s certificates to verify that all equipment used in the gas control system has been manufactured in accordance with industry standards.

NOTE: Authority cited: Sections 40502 and 45020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103 Public Resources Code; and Section 66796.22(d), Government Code.

§20945. [Reserved by SWRCB]

Subchapter 5. Closure and Post-Closure Maintenance
Article 1. General Standards For All Waste Management Units

20950. SWRCB - General Closure and Post-Closure Maintenance Standards Applicable to Waste Management Units (Units) for Solid Waste. (C15: §2580)

[Note: For landfills, see also §21790 et seq.]

(a) General.

(1) Applicability — Dischargers who are implementing final closure of a new or existing classified solid waste management unit (Unit) or are implementing complete final closure of a portion of a solid waste landfill (incremental closure under §21090(b)(1)(D)) shall comply with the provisions of this article. The discharger shall carry out both mandatory closure (under §22190) and normal closure (e.g., at the end of the active life of the Unit) in accordance with a closure and post-closure plan (under §21769) which the RWQCB finds meets all applicable requirements that section and of this Subchapter, including but not limited to applicable performance standards under .(a)(2). For the purposes of the RWQCB, the final closure plan the discharger submits under this section constitutes an amendment to the report of waste discharge (under §21750). If a portion of a Unit was completely closed in accordance with an approved closure plan by November 27, 1984, the cover over the closed portion does not need to be modified to conform to the SWRCB's additional closure requirements in these regulations, unless monitoring data indicate impairment of beneficial uses of ground water. Classified Units shall be closed according to an approved closure and post closure maintenance plan which provides for continued compliance with the applicable SWRCB-promulgated standards for waste containment and precipitation and drainage controls in Article 4, Subchapter 2, Chapter 3 of this subdivision ($20310 et seq.), and the monitoring program requirements in Article 5, Subchapter 2, Chapter 3 of this subdivision ($20380 et seq.), throughout the closure period and the post closure maintenance period. Relative to the applicable SWRCB-promulgated requirements of this title, the post closure maintenance period shall extend as long as the wastes pose a threat to water quality; for Units concurrently regulated by the RWQCB and by other state agencies (including the agents of such agencies), the RWQCB's finding that the waste in the Unit no longer poses a threat to water quality shall release the discharger only from the need to comply with the SWRCB-promulgated portions of this title, for that Unit. For land treatment facilities, relative only to the applicable SWRCB-promulgated requirements of this title, the post-closure maintenance period shall extend until treatment is complete.
(2) Performance Standards — The performance standards applicable to closure of a Unit and, for Units that are not clean-closed, to post-closure maintenance at the Unit are as follows:

(A) Unit Closed as a Landfill — for landfills that are not clean-closed and for waste piles and surface impoundments that are closed as a landfill:

1. Closure — for landfills and for waste piles and surface impoundments closed as landfills, the goal of closure, including but not limited to the installation of a final cover, is to minimize the infiltration of water into the waste, thereby minimizing the production of leachate and gas. For such Units, after closure, the final cover constitutes the Unit’s principal waste containment feature; and

2. Post-Closure Maintenance — the goal of post-closure maintenance at such Units is to assure that the Unit continues to comply with the performance standard of (a)(2)(A)1. until such time as the waste in the Unit no longer constitutes a potential threat to water quality;

(B) Unit Clean-Closed — for Units that are clean-closed, the goal of closure is to physically remove all waste and contaminated materials from the Unit and from its underlying and surrounding environs, such that the waste in the Unit no longer poses a threat to water quality. Successful completion of clean-closure eliminates the need for any post-closure maintenance period and removes the Unit from being subject to the SWRCB-promulgated requirements of this subdivision; and

(C) LTUs — for land treatment units (LTUs):

1. Closure — the goal of closure is to initiate the post-closure maintenance period;

2. Post-Closure Maintenance — the goal of post-closure maintenance is to continue Unit operations, without discharging additional waste to the Unit, in a manner which maximizes the degradation rate of the waste remaining within the treatment zone.

(b) Closure Supervision — Closure shall be under the direct supervision of a registered civil engineer or a certified engineering geologist.

(c) Unit Type — Class II Units and Class III landfills shall be closed in accordance with one of the following options:

1. landfill: pursuant to §21090;

2. surface impoundment: pursuant to §21400;

3. waste pile: pursuant to §21410; or

4. land treatment: pursuant to §21420.

(d) Surveying Monuments — Closed Units shall be provided with at least two permanent monuments installed by a licensed land surveyor or a registered civil engineer, from which the location and elevation of wastes, containment structures, and monitoring facilities can be determined throughout the post closure maintenance period.

(e) Vegetation — For landfills and for waste piles and surface impoundments that are closed as landfills, all vegetation for the closed Unit’s vegetative cover layer shall meet the requirements of §21090(a)(3)(A)1. [in cases where the Unit does not utilize the mechanically erosion resistant layer of §21090(a)(3)(A)2.]

(f) Closure/Post-Closure Financial Assurance — The RWQCB shall require the discharger to establish an irrevocable fund (or to provide other means) for closure and post-closure maintenance (see Articles 1 & 2 of Chapter 6 of this subdivision) to ensure closure and post closure maintenance of each classified Unit in accordance with an approved plan. [Note: corrective action financial assurance standards continue to apply throughout closure and post-closure maintenance (see §20380(b) & §22222.)] For landfills acquired by the CIWMB to have financial assurance mechanisms under Chapter 6, the RWQCB shall assist the CIWMB:

1. by verifying the amount of coverage proposed by the discharger to meet applicable SWRCB-promulgated requirements of this subdivision [Note: the CIWMB is responsible for the review, approval, and management of the financial assurance mechanisms for such Units]; and
Article 2. Closure and Post-Closure Maintenance Standards for Disposal Sites and Landfills

§21090. SWRCB - Closure and Post-Closure Maintenance Requirements for Solid Waste Landfills. (C15: §2581 // T14: §17777, §17779)
[Note: For SWRCB's final cover performance standard, see §20950(a)(2)(A); for related CIWMB requirements, see §21790 et seq.]

(a) Final Cover Requirements — Final cover slopes shall not be steeper than a horizontal to vertical ratio of one and three quarters to one, and shall have a minimum of one fifteen-foot wide bench for every fifty feet of vertical height. Designs having any slopes steeper than a horizontal to vertical ratio of three to one, or having a geosynthetic component [under .(a)], shall have these aspects of their design specifically supported in the slope stability report required under §21750(i)(5). The RWQCB can require flatter slopes or more benches where necessary to ensure preservation of the integrity of the final cover under static and dynamic conditions. The cost estimate, under §21769, for the final cover shall include a description of the type and estimated volume (or amount, as appropriate) of material needed for each component of the final cover based upon the assumption that all materials will need to be purchased; if on-site materials are to be used, the submittal shall include test results confirming the availability of such on-site materials and their suitability for such use. The RWQCB can allow any alternative final cover design that it finds will continue to isolate the waste in the Unit from precipitation and irrigation waters at least as well as would a final cover built in accordance with applicable prescriptive standards under .(a)(1-3).

(1) Foundation Layer — Closed landfills shall be provided with not less than two feet of appropriate materials as a foundation layer for the final cover. These materials may be soil, contaminated soil, incinerator ash, or other waste materials, provided that such materials have appropriate engineering properties to be used for a foundation layer. The foundation layer shall be compacted to the maximum density obtainable at optimum moisture content using methods that are in accordance with accepted civil engineering practice. A lesser thickness may be allowed for Units if the RWQCB finds that differential settlement of waste and ultimate land use will not affect the structural integrity of the final cover.

(2) Low-Hydraulic-Conductivity Layer — In order to protect water quality by minimizing the generation of leachate and landfill gas, closed landfills shall be provided with a low-hydraulic-conductivity (or low through-flow rate) layer consisting of not less than one foot of soil containing no waste or leachate, that is placed on top of the foundation layer and compacted to attain an hydraulic conductivity of either 1x10^-6 cm/sec (i.e., 1 ft/yr) or less, or equal to the hydraulic conductivity of any bottom liner system or underlying natural geologic materials, whichever is less permeable, or another design which provides a correspondingly low through-flow rate throughout the post-closure maintenance period. Hydraulic conductivity determinations for cover materials shall be as specified in Article 4, Subchapter 2, Chapter 3 of this subdivision [§20310 et seq.], but using water as the permeant, and shall be appended to the closure and post-closure maintenance report. For landfills or portions thereof in which the final cover is installed after July 18, 1997, as part of the final closure plan for the Unit, the discharger shall provide a plan, as necessary [see .(a)(4)], for protecting the low-hydraulic-conductivity layer from foreseeable sources of damage that could impair its ability to prevent the throughflow of water (e.g., desiccation, burrowing rodents, or heavy equipment damage).

(3) Erosion-Resistant Layer — The low-hydraulic-conductivity layer of .(a)(2) shall be directly overlain by an erosion-resistant layer, as follows.

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(A) Closed landfills shall be provided with an uppermost cover layer consisting of either:

1. Erosion-Resistance Via a Vegetative Layer — a vegetative layer consisting of not less than one foot of soil which:

   a. contains no waste (including leachate);
   b. is placed on top of all portions of the low-hydraulic-conductivity layer described in .(a)(2);
   c. is capable of sustaining native, or other suitable, plant growth;
   d. is initially planted — and is later replanted as needed to provide effective erosion resistance — with native or other suitable vegetation having a rooting depth not exceeding the depth to the top of the low-hydraulic-conductivity layer described in .(a)(2). For any proposed vegetative cover, the discharger shall propose a species mix which harmonizes with the proposed post-closure land use, and which requires as little long-term maintenance as feasible by virtue of its tolerance of the vegetative layer’s soil conditions (e.g., the presence of landfill gas), its resistant to foreseeable adverse environmental factors (e.g., climate, disease, and pests), its rapidity of germination and growth, its persistence and ease of self-propagation, its high percentage of surface coverage (sufficient to prevent surface erosion), and its minimal need for irrigation and maintenance; and
   e. by virtue of its composition, its maintained vegetation density, and its finished-and-maintained grade, will be resistant to foreseeable erosion effects by wind-scour, raindrop impact, and runoff; or

2. Mechanically Erosion-Resistant Layer — an erosion- and ultraviolet light-resistant layer which, by virtue of its composition and finished-and-maintained grade, resists foreseeable erosion effects by wind-scour, raindrop impact, and runoff (e.g., a 1-foot thick layer of cobbles, the interstices of which are filled with gravel).

(B) The discharger shall maintain all components of the erosion-resistant layer throughout the post-closure maintenance period, and, if closed after July 18, 1997, shall implement such maintenance in accordance with an approved Cover-Integrity Monitoring and Maintenance Program, pursuant to .(a)(4).

(4) Cover Maintenance Plan & Annual Cost Estimate — The final cover shall be designed and constructed to function with the minimum maintenance possible. For landfills and for other Units closed as landfills, if the closure occurs after July 18, 1997, the preliminary and final closure and post-closure maintenance plan shall incorporate a cover-integrity monitoring and maintenance program which includes at least the following components. The annualized post-closure maintenance plan cost analysis [of §21769(c)] shall include an itemized estimate of the annual cost of each component:

(A) Periodic Leak Search — a schedule for carrying out periodic monitoring of the integrity of the low-hydraulic-conductivity layer, including a method for effectively identifying and repairing breaches in that layer [for example and where allowed, by temporarily discontinuing active gas extraction and using surface gas probes or inserted soil gas probes to identify locations where landfill gas is emerging];

(B) Periodic Identification of Other Problem Areas — a schedule for periodically identifying and addressing other cover problems, including at least:

   1. areas of the vegetative cover, if any, requiring replanting;
   2. eroded portions of the erosion-resistant layer requiring regrading, repair, or (for areas where the problem persistently reoccurs) increased erosion resistance;
   3. eroded portions of the low-hydraulic-conductivity layer needing repair or replacement;
   4. areas lacking free drainage;
   5. areas damaged by equipment operation;
   6. [Reserved]; and
   7. localized areas identified in the iso-settlement survey [of .(e)(2)] as having sustained repeated or severe differential settlement.
(C) Prompt Cover Repair — a plan for repairing, in a timely manner, any breach or other cover problem discovered pursuant to (a)(4)(A or B). For any repairs of the low-hydraulic-conductivity layer, this plan shall either contain a Construction Quality Assurance (CQA) plan [under §21710(a)(5)], or shall accomplish this goal through the incorporation-by-reference of appropriate portions of an approved CQA plan; and

(D) Vegetation Maintenance — for a final cover utilizing a vegetated erosion resistant layer [under (a)(3)(A)1.], a plan for maintaining this vegetative cover, including fertilization, irrigation, elimination of species that violate the rooting depth limit [of (a)(3)(A)1.d.], replanting, and irrigation system maintenance.

(E) Discharges of Liquids to Covers.
   (A) Leachate and Gas Condensate — The discharge of leachate, gas condensate, or other waste liquids to any final-covered portion of an MSW landfill is subject to the restrictions under §20200(d). [Note: see also 1) definitions of “leachate” and “landfill gas condensate” in §20164, and 2) §20705(f), re: daily and intermediate cover.]
   (B) Other Liquids — The discharger shall moderate the application rate of liquids discharged to the cover for dust control, irrigation of the vegetative layer, or other non-disposal purpose in a manner that minimizes the potential for throughflow to the underlying waste. The RWQCB can establish cover throughflow monitoring requirements (e.g., via intermittent tensiometer measurements of the cover) to ensure compliance with this requirement.

(F) Stability Analysis — For any portions of the final cover installed after July 18, 1997, for which the RWQCB has not approved a slope and foundation stability report or before that date, the discharger shall meet the requirements of §21750(b)(5).

(b) Grading Requirements.
   (1) Prevent Ponding, Erosion, and Run-Ons.
      (A) General — The final drainage plan shall be included as part of the approved final closure plan for the Unit. In spite of differential settlement, the final cover of closed landfills (including waste piles and surface impoundments closed as landfills) shall be designed, graded, and maintained to prevent ponding and to prevent soil erosion due to high run-off velocities. Except as provided in (b)(1)(B), all portions of the final cover shall have a slope of at least three percent. [Note: for additional requirements concerning final grading, see §21142.]
   (B) Flatter Areas — The RWQCB can allow portions of the final cover to be built with slopes of less than three percent if the discharger proposes an effective system for diverting surface drainage from laterally-adjacent areas and preventing ponding in the allowed flatter portion. Analyses submitted in support of such a proposal shall take into account the design storm intensity for the Unit [under §20365].

(C) Qualified Professional — The final grading design shall be designed and approved by a registered civil engineer or certified engineering geologist to meet the performance standards of (b)(1)(A and B), taking into consideration pertinent natural and constructed topographic features (including any related to the proposed post-closure land use), and climate.

(D) Prompt Incremental Closure — This paragraph applies unless the RWQCB has approved, as part of the final closure plan, a waiting period (for installation of the final cover) not to exceed five years after the date a portion of the landfill reaches final elevation, in order to avoid subjecting the final cover to potential damage from the high rate of differential settlement that so often occurs during the first few years following the final receipt of waste. To the extent feasible, based on site-specific factors, the complete closure, including final grading and installation of the final cover, for each portion of the landfill shall be implemented as soon as possible after that portion reaches final elevation. [For additional related requirements, see (c), §§21110, §21120.]

(E) CQA — After July 18, 1997, both the initial construction of the final cover and any later repair work that involves the cover’s low-hydraulic-conductivity layer [of (a)(2)] shall be carried out in accordance with an approved CQA plan [see §§20323 & §§20324].

(2) Steeper-Sloped Portions — Areas with slopes greater than ten percent, areas having surface drainage courses, and areas subject to erosion by water or wind shall be protected from erosion or shall be designed and constructed to prevent erosion.
(3) **Precipitation & Drainage Plan** — The final closure plan for the Unit shall incorporate a precipitation and drainage control plan for the closed landfill, and shall meet the requirements of §20365.

(c) **General Post-Closure Duties** — Throughout the post closure maintenance period, the discharger shall:

1. maintain the structural integrity and effectiveness of all containment structures, and maintain the final cover as necessary to correct the effects of settlement or other adverse factors;

2. continue to operate the leachate collection and removal system as long as leachate is generated and detected;

3. maintain monitoring systems and monitor the ground water, surface water, and the unsaturated zone in accordance with applicable requirements of Article 1, Subchapter 3, Chapter 3, Subdivision 1 (§20380 et seq.);

4. prevent erosion and related damage of the final cover due to drainage; and

5. protect and maintain surveyed monuments [installed under §20950(d)].

(d) **Landfill Closure Deadline** — For landfill Units subject to the CIWMB-promulgated provisions of this division, any closure deadline extensions the discharger proposes to the EA (under §21110) shall be effective only after concurrence by the RWQCB.

(e) **Final Cover Surveys.**

This subsection [i.e., through (e)(3)] applies only to landfills, or portions thereof, that are final-closed after July 18, 1997.

1. **Initial Survey and Map** — For a closed landfill (including a surface impoundments or waste pile closed as a landfill), upon completion of all closure activities for the Unit (or portion thereof) pursuant to .(b)(1)(D), the discharger shall conduct an aerial photographic survey [or alternative survey under (e)(3)] of the closed portions of the Unit and of its immediate surrounding area, including at least the surveying monuments [of §20950(d)]. The data so obtained shall be used to produce [or to augment, in the case of incremental closure under .(b)(1)(D)] a topographic map of the site at a scale and contour interval sufficient to depict the as-closed topography of each portion of the Unit, and to allow the early identification of any differential settlement, pursuant to .(c)(2). For landfills undergoing incremental closure [under (b)(1)(D)], the survey for each closed portion of the landfill shall be carried out immediately following completion of closure activities for that portion of the landfill; such data shall be used to create or augment a map showing the closure date and as-closed topography of each portion of the Unit. The map produced pursuant to this paragraph shall act as a base-line against which to measure the total settlement, through time, of all portions of the final cover since the date when that landfill, or portion thereof, was closed. Upon completion of this topographic map (or, in the case of incremental closure, of each revision thereof), the discharger shall submit a copy to the RWQCB, the CIWMB, and the EA.

2. **Five-Yearly Iso-Settlement Map** — At least every five years after completing closure of the landfill [or of the last remaining portion, for landfills undergoing incremental closure under (b)(1)(D)], the discharger shall produce and submit to the RWQCB an iso-settlement map accurately depicting the estimated total change in elevation of each portion of the final cover's low-hydraulic-conductivity layer. Therefore, for each portion of the landfill, this map shall show the total lowering of the surface elevation of the final cover, relative to the baseline topographic map (of .(e)(1)), and shall indicate all areas where visually noticeable differential settlement [noted under (e)(4)] may have been obscured by grading operations. The map shall be drawn to the same scale and contour interval as the topographic map under .(e)(1), but showing the current topography of the final cover and featuring overprinted isopleths indicating the total settlement to-date. The RWQCB shall apply the requirements of this paragraph only to a closed landfill which the RWQCB finds is likely to experience differential settlement of such magnitude as to impair either the Unit's containment features (e.g., final cover) or the free drainage of surface flow. [Note: The RWQCB's choosing to forego requiring iso-settlement mapping for the purpose of water quality protection does not preclude the CIWMB/EA from requiring such mapping for other purposes (e.g., structural integrity considerations regarding a building sited on top of the closed landfill); see §21142(b).]
(3) Alternative Surveying Techniques — The RWQCB can approve the use of any alternative technique (to an aerial survey) for producing the maps required by .(e)(1 & 2), so long as the maps so produced meet the performance standards of .(e)(1 & 2).

(4) Tracking Differential Settlement — Prior to conducting periodic grading operations on the closed landfill [under .(b)(1)(A)], the discharger shall note on a map of the landfill the approximate location and outline of any areas where differential settlement is visually obvious. Each five-yearly iteration of the iso-settlement map [under .(e)(2)] shall show all areas where differential settlement has been noted (under this paragraph) since the previous map submittal, and shall highlight areas of repeated or severe differential settlement. Map notations and delineations made pursuant to this paragraph need not be surveyed, so long as all areas where differential settlement was visually identifiable prior to regrading can be relocated. Such notation and delineation shall be made by, or under the supervision of, a registered civil engineer or registered geologist.

(f) Optional Clean-Closure — Notwithstanding any other SWRCB-promulgated closure or post-closure maintenance requirement in this subdivision, a discharger proposing to clean-close a landfill shall submit a clean-closure plan meeting the requirements of this subsection. [Note: see also CIWMB’s additional landfill clean-closure requirements under §21810.] The purpose of clean-closure is to render the landfill (including all surrounding environs contaminated by waste released from the landfill) no longer capable of posing a threat to water quality. The purpose of a clean-closure plan is to propose a series of actions, including an accurate estimate of the cost of each such action, that will meet the requirements of this paragraph. Upon the RWQCB’s finding that the discharger has successfully completed clean-closure under this paragraph, the landfill shall no longer be subject to the SWRCB-promulgated requirements of this title. Nevertheless, if the RWQCB finds that the discharger’s attempt to clean-close the landfill does not meet the requirements of this subsection, the discharger shall close the landfill and carry out post-closure maintenance in the same manner as though the discharger had not attempted clean-closure. For the purpose of this paragraph, the discharger shall have successfully clean-closed a landfill only if:

(1) all waste materials, contaminated components of the containment system, and affected geologic materials — including soils and rock beneath and surrounding the Unit, and ground water polluted by a release from the Unit — are either removed and discharged to an appropriate Unit or treated to the extent that the RWQCB finds they no longer pose a threat to water quality; and

(2) all remaining containment features are inspected for contamination and, if contaminated, discharged in accordance with .(f)(1).


§21099. CIWMB - Purpose. (new)

(a) For purposes of the CIWMB promulgated sections of this article, “closed” refers to the status of a disposal site that either 1) has received a closure certification pursuant to §21880, or 2) has, on or before November 18, 1990, completed all closure activities required pursuant to regulations in effect at the time of the last receipt of waste.

(b) For purposes of the CIWMB promulgated sections of this article, “closing” means the period that commences when implementation of an approved final closure or partial final closure plan begins, and that ends when implementation of an approved final closure or partial final closure plan is complete.


§21100. CIWMB - Scope and Applicability. (T14-§17760)

(a) This article sets forth the performance standards and the minimum substantive requirements for proper closure, postclosure maintenance and ultimate reuse of disposal sites. The EA may require the operator or owner to address site-specific conditions as part of the solid waste facility permit or any plan needed for closure of the site to ensure that public health and safety and the environment are protected. [For water quality aspects of closure and/or postclosure maintenance, refer to requirements set forth in §20950.]
(b) The regulations contained in this article apply to:

(1) disposal sites that did not complete closure prior to November 18, 1990, in accordance with all applicable requirements; and

(2) new postclosure activities that may jeopardize the integrity of previously closed disposal sites or pose a potential threat to public health and safety or the environment.

(c) All closure plans submitted after the effective date of the regulations shall conform to the regulations in this article. Closure plans submitted prior to the effective date of this article that have been deemed complete and for which detailed comments have been supplied by the CIWMB and the EA within 12 months of the original submittal date shall not need to be resubmitted. Closure plans submitted prior to the effective date of this article that have been deemed complete but for which detailed comments have not yet been supplied by the CIWMB and the EA may not need to be resubmitted.

(d) Closed sites for which closure plans were not approved pursuant to §20164 or §21099, and illegal or abandoned disposal sites which pose a threat to public health and safety or the environment shall implement the provisions of these regulations as required by the EA.

(e) [Reserved]

(f) The EA shall apply these regulations to non-MSWLF units, except for disposal sites that have received household or commercial wastes, only as necessary to protect public health and safety, until such time as those non-MSWLF units or disposal sites have been placed into the regulatory tier structure set forth in Subchapter 2 of Chapter 4 (§21460 et seq.) The EA shall implement these regulations in coordination with RWQCB or other agencies as applicable.

[Note: Subsection (e) (reserved) has been added to address closure of disposal sites which have been or will be slotted by the Board into regulatory tiers (e.g. non-MSWLF construction and demolition landfills and monofills for ash and contaminated soils).


21110. CIWMB - Time Frames for Closure. (T14:§17763, parts of §17258.60 and 17258.61)

(a) Within thirty (30) days of receipt of the final shipment of waste to a discrete unit or if the entire disposal site has reached permitted capacity, the operator shall begin implementation of the closure schedule as specified in the approved closure plan.

(b) Closure activities shall adhere to the time frames specified in the approved closure plan.

(c) In the event that the time frames for completion of specific activities cannot be adhered to due to adverse weather or other factors not in the control of the operator, then the time frames may be lengthened based upon those specific factors.

(1) The operator shall notify the EA of any change in schedule due to adverse weather or other factors not in their control. The notification shall be made as soon as the operator becomes aware of a needed change.

(2) The EA may deny the change requested pursuant to .(c)(1) if the factors justifying the change are in the control of the operator.

(d) The owner or operator of a solid waste landfill must complete closure activities in accordance with the approved closure plan within 180 days following the beginning of closure. Extensions of the closure period may be granted by the EA if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and the owner or operator has taken and will continue to take all steps to prevent threats to human health and safety and the environment from the unclosed solid waste landfill.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code, and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code, and Sections 66796.22(d) and 66798.22(g) Government Code.
.21120. CIWMB - Partial Final Closure. (T14:§17764)
  (a) The operator shall to the extent feasible, based on site specific factors, implement partial and/or partial final closure activities as the site operation progresses, consistent with the closure of the entire site.
  
  (b) Partial closure may be accomplished by implementing one or a combination of individual closure activities pursuant to CIWMB and SWRCB requirements including, but not limited to: placement of final cover, final grading, drainage control, revegetation, and installation of environmental monitoring and/or control systems (all of the foregoing) consistent with the approved closure and postclosure maintenance plan.
  
  (c) Partial final closure may be accomplished by closing discrete units in a manner consistent with the approved closure and postclosure maintenance plan.
  
  (d) The approval and implementation of any closure plan for a portion of the landfill shall be subject to the same process and time frames as for the approval and implementation of a closure and postclosure maintenance plan for the entire landfill (see §21110 and §21860).

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Sections 66796.22(d) and 66796.22(g), Government Code.

§21125. CIWMB - Clean Closure. [Reserved]

.21130. CIWMB - Emergency Response. (T14:§17766)
  Water quality protection aspects for emergency response plan are addressed in §21132.
  
  (a) The operator shall maintain a written postclosure emergency response plan at the facility or at an alternate location as approved by the EA. The emergency response plan must identify occurrences that may exceed the design of the site and endanger public health or the environment. The plan shall describe specific procedures that minimize these hazards to protect public health and safety. The events that the plan shall address include, but are not limited to: vandalism, fires, explosions, earthquakes, floods; the collapse or failure of artificial or natural dikes, levees or dams; surface drainage problems; and other waste releases.
  
  (b) The emergency response plan shall contain the following:
  
  (1) identification of events which could require the implementation of emergency response actions. This section shall not apply to the gas monitoring provisions;
  
  (2) a description of the actions to be taken, and the sequence and implementation timetable needed to mitigate the conditions; and
  
  (3) a statement regarding the general availability of equipment required to mitigate each type of emergency.
  
  (c) The operator shall amend the emergency response plan under the following conditions:
  
  (1) whenever a failure or release occurs for which the plan did not provide an adequate response;
  
  (2) when the postclosure land use and/or structures on the site change and these changes are not addressed in the existing plan; or
  
  (3) if the EA notifies the operator in writing that the current emergency response plan is inadequate under the provisions of this section. The notifying agency shall include within the written notice the items the plan needs to consider for it to comply with this section. The operator shall submit an amended emergency response plan to the EA within thirty (30) days of notification of an inadequacy.
  
  (d) Whenever the operator amends the emergency response plan pursuant to .(c)(1 or 2), the operator shall submit a written copy of the amended plan to the EA.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Sections 66796.22(d) and 66796.22(g), Government Code.
.21132. SWRCB - Landfill Emergency Response Plan Review. (new)

(a) Review & Notification — For landfills, the RWQCB shall review the emergency response plan, in coordination with the Enforcement Agency (EA), to assure that no proposed response to a foreseeable emergency will result in a threat, or increased threat, to beneficial uses of waters of the state.

(b) Submittal — For landfills for which the CIWMB requires an emergency response plan (e.g., pursuant to §21130), the discharger shall submit a copy of that plan, including any proposed amendments thereto, to the RWQCB. For landfills having an existing emergency response plan that has already been reviewed by the RWQCB, the discharger need not resubmit the plan for review by the RWQCB until such time as the plan is amended. For landfills having an existing emergency response plan (i.e., approved by the EA) that has not as yet been reviewed by the RWQCB, the discharger shall submit a current copy of the plan for RWQCB review prior to July 18, 1998. For proposed emergency response plans (including proposed amendments to an existing plan), this submittal shall occur at the same time as the discharger submits the proposed plan to the EA.

(c) Coordinate On New Response — In the event that the discharger proposes to respond to an emergency in a manner other than specified in the emergency response plan, the RWQCB shall coordinate with the EA to assure that the proposed response does not pose a threat to water quality.


.21135. CIWMB - Site Security. (T14:§17767)

(a) Sign(s) shall be posted at all points of access to a site sixty (60) days prior to the last receipt of waste at the site and for a period of not less than one hundred eighty (180) days after the facility has received the final shipment of waste stating the intended date of last receipt of waste at the site and the location of alternative permitted solid waste management facilities. A notice shall be placed in a local newspaper(s) thirty (30) days prior to the last receipt of waste which includes the intended date of the last receipt of waste at the site and the location of alternative solid waste management facilities.

(b) Sites which do not allow public disposal and which have not allowed public access to the site for more than one year prior to cessation of acceptance of waste, or are undertaking partial final closure pursuant to §21120, shall be exempt from the provisions of this section.

(c) The EA may require more signs, signs written in additional languages, larger signs, or signs of clearer design, if necessary to protect public health and safety.

(d) The EA may grant variances from the sign provisions of this section after receiving a written request by the operator.

(e) Sedimentation and detention basins shall be secured and maintained during the closure and postclosure maintenance period to prevent unauthorized access.

(f) The operator shall ensure that all points of access to the site are restricted to protect public health and safety as of the date the final shipment of waste is received. Components of any monitoring, control or recovery systems at the site shall be protected from access other than that allowed in accordance with the approved closure and postclosure maintenance plans.

(g) Once closure activities are complete, site access by the public may be allowed in accordance with the postclosure maintenance plan, as approved by the EA.

Note: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Section 44100 and 43103, Public Resources Code.

.21137. CIWMB - Structure Removal. (T14:§17771)

(a) the operator shall dismantle and remove site structures at the time of closure to protect public health and safety in accordance with the implementation schedule of the approved final closure plan.
(b) The operator shall ensure that structures and components of landfill gas and leachate control systems not intended for reuse that have come into contact with leachate or landfill gas, and that are dismantled at the time of closure or during the postclosure period are:

(1) disposed of within the landfill, in accordance with the approved final closure plan; or

(2) transported to another solid waste facility which is approved for receipt of such materials. Transportation and disposal should be accomplished in a manner to protect public health and safety.

NOTE: Authority cited: Sections 40504 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources; and Section 66796.22(d), Government Code.

21140. CIWMB - Final Cover. (T14:§17773)

(a) The final cover shall function with minimum maintenance and provide waste containment to protect public health and safety by controlling at a minimum, vectors, fire, odor, litter and landfill gas migration. The final cover shall also be compatible with postclosure land use.

(b) In proposing a final cover design meeting the requirements under §21090, the owner or operator shall assure that the proposal meets the requirements of this section. Alternative final cover designs shall meet the performance requirements of (a) and, for MSWLF units, 40 CFR 258.60(b); shall be approved by the enforcement agency for aspects of (a).

(c) The EA may require additional thickness, quality, and type of final cover depending on, but not limited to the following:

(1) a need to control landfill gas emissions and fires;

(2) the future reuse of the site; and

(3) provide access to all areas of the site as needed for inspection of monitoring and control facilities, etc.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

21142. CIWMB - Final Grading. (T14:§17776,§17777)

(a) Final grades must be designed and maintained to reduce impacts to health and safety and take into consideration any postclosure land use. [Note: for final grading requirements concerning water quality protection, see section §21090(b).]

(b) Subsequent to the creation and submittal of the initial postclosure topographic map, pursuant to §21090(e)(1), the EA shall require the owner and/or operator to produce five-yearly iso settlement maps meeting the requirements of §21090(e)(2) and (3) only if:

(1) the RWQCB does not require such maps (for the purpose of water quality protection at the landfill); and

(2) the EA finds that such maps are needed for reasons other than water quality protection.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 43021, 43103 and 44100, Public Resources Code; and Section 66796.22(d), Government Code.

21145. CIWMB - Slope Stability. (T14:§17777)

(a) The operator shall ensure the integrity of final slopes under both static and dynamic conditions to protect public health and safety and prevent damage to postclosure land uses, roads, structures, utilities, gas monitoring and control systems, leachate collection and control systems to prevent public contact with leachate, and prevent exposure of waste. Slope stability analyses shall be conducted and reported pursuant to the requirements of Division 2, Subdivision 1, Chapter 4, Subchapter 3, Article 4 Section 21750(f)(5).

(b) The operator shall notify the EA, CIWMB, and RWQCB in the event of any slope failure.
21150. CIWMB - Drainage and Erosion Control. (T14:§17778 & §17779)

[Water quality protection aspects for drainage and erosion control are addressed in §20365 and §21090, and in Table 4.1 in Article 4, Subchapter 2, Chapter 3 of this subdivision.]

(a) The drainage and erosion control system shall be designed and maintained to ensure integrity of postclosure land uses, roads, and structures; to prevent public contact with waste and leachate; to ensure integrity of gas monitoring and control systems; to prevent safety hazards; and to prevent exposure of waste.

(b) In cases where the design precipitation event in Table 4.1, Article 4, Subchapter 2 of Chapter 3, is not adequate for the protection of public health and safety, the EA, in consultation with the RWQCB, may require the implementation of a more stringent design.

(c) Slopes not underlain by waste shall be stabilized to prevent soil erosion. Methods used to protect slopes and control erosion shall include, but are not limited to, terracing, contour furrows, and trenches.

(Note: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.)

21160. CIWMB - Landfill Gas Control and Leachate Control. (T14:§17781, 17783)

(a) The operator shall implement and maintain landfill gas control and prevent leachate contact with the public or animals according to the requirements of this section.

(b) Gas monitoring and control shall be conducted during the closure and postclosure maintenance period pursuant to Article 6, Subchapter 4 of this chapter.

(c) During the closure/postclosure maintenance period, the owner/operator shall ensure that leachate collection and control is done in a manner which prevents public contact and controls vectors, nuisance and odors.

(d) In designing the LCRS to meet the requirements under §20340, the owner/operator shall also assure that the LCRS neither:

(1) interferes with landfill gas control; nor

(2) promotes landfill gas migration.

(Note: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Section 44100 and 43103, Public Resources Code.)

21170. CIWMB - Recording. (T14:§17787)

(a) The owner or operator, upon completion of closure of the site, shall file a detailed description of the closed site, including a map, with the Recorder of the County in which the site is located, with the EA and with the local agency that has been selected to maintain the county integrated waste management plan. The site description, upon completion of closure of the site, shall include but not be limited to the following:

(1) the date that closure was completed;

(2) the boundaries including height and depths of the filled area. If the site was closed in increments, the boundaries of each waste management unit;

(3) the location where the closure and postclosure plans can be obtained; and

(4) a statement that the future site use is restricted in accordance with the postclosure maintenance plan.

(Note: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 44100 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.)
21180. CIWMB - Postclosure Maintenance. (T14:§17788)

[Water quality protection aspects for postclosure maintenance are addressed in §21090.]

(a) Postclosure maintenance for the purposes of reducing impacts to health and safety, shall be conducted to ensure the integrity of the final cover and environmental control systems. The landfill shall be maintained and monitored for a period of not less than thirty (30) years after the completion of closure of the entire solid waste landfill. Any areas in which final cover is placed prior to the closure of the entire landfill shall be maintained in accordance with an approved postclosure maintenance plan, but the thirty (30) year monitoring period shall not commence until closure of the entire landfill is complete. Maintenance and monitoring shall include, but not be limited to the following:

(1) site security;

(2) gas monitoring and control system maintenance as specified in the final closure and postclosure maintenance plans.

(b) If nonliquid waste is exposed during postclosure maintenance activities at a solid waste landfill, the waste may be returned to that landfill provided that the integrity of the final cover is maintained.

(c) The operator shall provide to the CIWMB and the EA copies of the maps and reports provided to the RWQCB pursuant to §21090(e)(2) describing the amount of differential settlement.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796(d), Government Code. Reference: Section 43021 and 43103, Public Resources Code; and Section 66796.22(d), Government Code.

21190. CIWMB - Postclosure Land Use. (T14:§17796)

(a) Proposed postclosure land uses shall be designed and maintained to:

(1) protect public health and safety and prevent damage to structures, roads, utilities and gas monitoring and control systems;

(2) prevent public contact with waste, landfill gas and leachate; and

(3) prevent landfill gas explosions.

(b) The site design shall consider one or more proposed uses of the site toward which the operator will direct its efforts, or shall show development as open space, graded to harmonize with the setting and landscaped with native shrubbery or low maintenance ground cover.

(c) All proposed postclosure land uses, other than non-irrigated open space, on sites implementing closure or on closed sites shall be submitted to the EA, RWQCB, local air district and local land use agency. The EA shall review and approve proposed postclosure land uses if the project involves structures within 1,000 feet of the disposal area, structures on top of waste, modification of the low permeability layer, or irrigation over waste.

(d) Construction on the site shall maintain the integrity of the final cover, drainage and erosion control systems, and gas monitoring and control systems. The owner or operator shall demonstrate to the satisfaction of the EA that the activities will not pose a threat to public health and safety and the environment. Any proposed modification or replacement of the low permeability layer of the final cover shall begin upon approval by the EA, and the RWQCB.

(e) Construction of structural improvements on top of landfilled areas during the postclosure period shall meet the following conditions:

(1) automatic methane gas sensors, designed to trigger an audible alarm when methane concentrations are detected, shall be installed in all buildings;

(2) enclosed basement construction is prohibited;

(3) buildings shall be constructed to mitigate the effects of gas accumulation, which may include an active gas collection or passive vent systems;

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(4) buildings and utilities shall be constructed to mitigate the effects of differential settlement. All utility connections shall be designed with flexible connections and utility collars;

(5) utilities shall not be installed in or below any low permeability layer of final cover;

(6) pilings shall not be installed in or through any bottom liner unless approved by the RWQCB;

(7) if pilings are installed in or through the low permeability layer of final cover, then the low permeability layer must be replaced or repaired; and

(8) periodic methane gas monitoring shall be conducted inside all buildings and underground utilities in accordance with §20933 of Article 6, of Subchapter 4 of this Chapter.

(f) The EA may require that an additional soil layer or building pad be placed on the final cover prior to construction to protect the integrity and function of the various layers of final cover.

(g) All on site construction within 1,000 feet of the boundary of any disposal area shall be designed and constructed in accordance with the following, or in accordance with an equivalent design which will prevent gas migration into the building, unless an exemption has been issued:

1. a geomembrane or equivalent system with low permeability to landfill gas shall be installed between the concrete floor slab of the building and subgrade;

2. a permeable layer of open graded material of clean aggregate with a minimum thickness of 12 inches shall be installed between the geomembrane and the subgrade or slab;

3. a geotextile filter shall be utilized to prevent the introduction of fines into the permeable layer;

4. perforated venting pipes shall be installed within the permeable layer, and shall be designed to operate without clogging;

5. the venting pipe shall be constructed with the ability to be connected to an induced draft exhaust system;

6. automatic methane gas sensors shall be installed within the permeable gas layer, and inside the building to trigger an audible alarm when methane gas concentrations are detected; and

7. periodic methane gas monitoring shall be conducted inside all buildings and underground utilities in accordance with Article 6, of Subchapter 4 of this chapter (§20920 et seq.).

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 45021, 43103 and 44105, Public Resources Code; and Section 66796.22(d), Government Code.

§21194. [Reserved by SWRCB]

.21200. CIWMB - Change of Ownership During Closure or Postclosure Maintenance.

(T14:§17792)

(a) Before the title to a disposal site is transferred to another person during closure or postclosure maintenance, the new owner shall be notified by the previous owner or his agent of the existence of these standards and of the conditions and agreements assigned to assure compliance.

(b) The previous owner shall notify the EA of the change in title within thirty (30) days and shall provide the name, firm, mailing address, and telephone number of the new owner.

NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 45021, 43103 and 44105, Public Resources Code; and Section 66796.22(d), Government Code.
Article 3. SWRCB - Closure Standards for Units Other Than Landfills
21400. SWRCB - Closure Requirements for Surface Impoundments. (C15: §2582)
(a) Remove Free Liquids — All free liquid remaining in a surface impoundment at the time of closure shall be
removed and discharged at an approved waste management unit (Unit). All residual liquid shall be treated to
eliminate free liquid.

(b) Options — Following removal and treatment of liquid waste, impoundments shall be closed in one of two
ways, as approved by the RWQCB.

(1) Mandatory Clean-Closure Attempt — Unless the discharger demonstrates, and the RWQCB finds, that it
is infeasible to attempt clean-closure of the impoundment, then all residual wastes, including sludges, precipitates,
settled solids, and liner materials contaminated by wastes, shall be completely removed from the impoundment and
discharged to an approved Unit. Remaining containment features shall be inspected for contamination and, if not
contaminated, can be dismantled. Any natural geologic materials beneath or adjacent to the closed impoundment
that have been contaminated shall be removed for disposal at an appropriate Unit. For surface impoundments that
are successfully clean-closed, as herein described, the RWQCB shall declare the Unit no longer subject to the
SWRCB-promulgated requirements of this title. If, after reasonable attempts to remove such contaminated
materials, the discharger demonstrates that removal of all remaining contamination is infeasible, the surface
impoundment shall be closed as a landfill or land treatment unit, as appropriate, pursuant to .(b)(2).

(2) Fallback Closure Options — In cases where clean-closure [under .(b)(1)] is infeasible, the discharger
shall propose for RWQCB approval either:

(A) Closure As a Landfill — that all residual wastes, including sludges, precipitates, settled solids, and liner
materials, shall be compacted, and the Unit shall be closed as a landfill pursuant to §21090, provided that the
closed Unit meets applicable standards for landfill Units in Articles 3 and 4 of Subchapter 2, Chapter 3,
Subdivision 1 of this division (§20240 et seq.), and further provided that the moisture content of residual wastes,
including sludges, does not exceed the moisture holding capacity of the waste either before or after closure; or

(B) Closure As an LTU — for surface impoundments which contain only decomposable wastes at closure,
that the Unit be closed as a land treatment unit under §21420(a)(2 B 4).
NOTE: Authority cited: Section 1058, Water Code. Reference: Section 13172, Water Code; Section 43103,
Public Resources Code.

21410. SWRCB - Closure Requirements for Waste Piles. (C15: §2583)
(a) Options — Waste piles shall be closed in one of two ways, as approved by the RWQCB.

(1) Mandatory Clean-Closure Attempt — Unless the discharger demonstrates, and the RWQCB finds, that it
is infeasible to attempt clean-closure of the waste pile, then all waste materials and any components of the
containment system which are contaminated by wastes shall be removed from the waste pile and discharged to an
appropriate Unit. Remaining containment features shall be inspected for contamination and, if not contaminated,
can be dismantled. Any soil or other materials beneath the closed waste pile that have been contaminated shall be
removed for disposal at an appropriate Unit. If, after reasonable attempts to achieve clean-closure (as herein
described), the discharger demonstrates that removal of all remaining contamination is infeasible, then the
remaining portions of the waste pile (including all contaminated portions of the underlying and surrounding
geologic materials) shall be closed as a landfill pursuant to .(a)(2) and §21090.

(2) Fallback Options — In cases where clean-closure [under .(a)(1)] is infeasible, the discharger shall
propose for RWQCB approval either of the following options, as appropriate.

(A) Closure As a Landfill — A waste pile can be compacted, covered, and closed as a landfill §21090,
provided that the discharger has met the requirements of .(a)(1), and further provided that the closed Unit either
meets applicable standards for landfill Units in Articles 3 and 4 of Subchapter 2, Chapter 3, Subdivision 1 of this
division (§20240 et seq.), or contains only dry waste and was not required to have a leachate collection and
removal system under §20340(a).
(B) Closure As an LTU — Waste piles which contain only decomposable wastes may be closed as a land treatment unit under §21420(a)(2 B 4).


21420. SWRCB - Closure Requirements for Land Treatment Units (LTUs). (C15: §2584)
(a) During the closure and post closure period, the discharger shall:

(1) continue all operations necessary to maximize degradation, transformation, or immobilization of waste constituents within the treatment zone;

(2) continue all ground water and unsaturated zone monitoring in compliance with Article 1, Subchapter 3, Chapter 3, Subdivision 1 of this division (§20930 et seq);

(3) continue all operations in the treatment zone to prevent runoff of waste constituents; and

(4) maintain the precipitation and drainage control systems.


Article 4. Standards for Composting Facilities [Reserved]
§21430. CIWMB - Compost Facility Closure Requirements. [Reserved]

Chapter 4. Documentation and Reporting For Regulatory Tiers, Permits, WDRs, and Plans

Subchapter 1. CIWMB - General

§21440. Purpose. (non-regulatory) [Reserved]

.21450. CIWMB - Scope/Applicability/Coordination. (T14:§18200)
(a) The CIWMB-promulgated sections of this chapter set forth the method of application for a Solid Waste Facility Permit (SWFP) and procedures for review and action on the application package. Also dealt with in this chapter are related matters of application for permits, reinstatement of permits after disciplinary actions, periodic revision of permits, exemptions from the application and permit requirements, and updating of certain application information. Related matters of modification, suspension, or revocation of permits upon investigation by the EA are included in PRC §44001 et seq. and §44300 et. seq.

(b) Pursuant to §20005 the EA shall coordinate all permitting aspects for disposal sites, including review of the JTD, with the RWQCB as appropriate.


History
1. New article 3 (sections 18200-18217, not consecutive) files 6-27-77; designated effective 7-1-77 (Register 77, No. 22).
2. Change without regulatory effect amending section filed 5-17-91 pursuant to section 100, title 1, California Code of Regulations (Register 91, No. 27).
3. Amendment of section and Note filed 7-15-93; operative 7-15-93 (Register 93, No. 29).

Subchapter 2. CIWMB - Regulatory Tiers [§21460-$21560 Reserved by CIWMB]
Subchapter 3. Development of Waste Discharge Requirements (WDRs) and Solid Waste Facility Permits

Article 1. General

21563. CIWMB - Scope. (T14:S18200, S18200.1)

(a) This Subchapter sets forth the method of application for a full solid waste facility permit and procedures for review and action on the application package. This Subchapter also addresses related matters of exemptions from the permit requirements, application for changes in design or operation, reinstatement of permits after disciplinary actions, periodic reviews and revisions of permits, and amending application information. Matters related to EA actions to amend, suspend or revoke permits are included in Article 2, Chapter 5.

(b) The provisions of this Subchapter shall apply to solid waste facilities or disposal sites and any other operations requiring a full SWFP as noted in this Division. Specific provisions of this Subchapter outlining the different responsibilities of the applicant, EA and the CIWMB may be found below as follows:

2. Applicant Requirements  Article 2.
3. EA Requirements  Article 3.
4. CIWMB Requirements  Article 3.1.

(c) Except as otherwise noted, for purposes of this chapter only, “facility” means solid waste facility and/or disposal site or any other operation requiring a full SWFP as noted in this division.

(d) For purposes of these articles (Articles 1-3.1), the following definitions apply:

1. “Complete” means all requirements placed upon the operation of the solid waste facility by statute, regulation, and other agencies with jurisdiction have been addressed in the application package.

2. “Correct” means all information provided by the applicant regarding the solid waste facility must be accurate, exact, and must fully describe the parameters of the solid waste facility.

3. “Application Filing” means the enforcement agency has determined the application package is complete and correct and the statutory time limit contained in PRC Section 44008 commences.


21565. CIWMB - Exemptions from Requirement of a Permit. (T14:S18215)

(a) After a public hearing the EA may grant an exemption from the requirement that the operator of a facility obtain a permit. Such an exemption may be granted if the facility falls within one of the classifications. (b) and all of the following findings are made:

1. The exemption is not against the public interest.
2. The quantity of solid wastes is insignificant.
3. The nature of the solid wastes poses no significant threat to health, safety, or the environment.

(b) Classifications of solid waste facilities that may be exempted are:

1. Facilities or portions thereof doing research funded primarily by government grants;
2. Construction disposal sites for short-term use (less than 90 days), in which only inert wastes are to be placed by city, county, or state agencies;
3. Drilling mud disposal sumps for short-term use (less than one year) if significant quantities of hazardous or toxic materials are not present in the mud, fluids and cuttings from drilling and associated operations; [Note: currently, on-site sumps are exempted under T23 §2511(g) & in §20090(g) of this subdivision]
4. Unclassified waste management units as defined by the State Water Resources Control Board (SWRCB);
(5) Farm or ranch disposal sites for one- or two-family use;

(6) Resource Recovery facilities intended only for demonstration purposes and not for profit;

(7) Disposal sites to be used exclusively for one of the following: for spreading of either canny wastes or oily wastes, mine tailings, ashes and residues, agricultural wastes, street sweepings, dirt from excavations, slag if disposed of on site, or waste water treatment sludge if disposed of on site or to specified agricultural lands; and

(8) Evaporation ponds for disposing of salts from oil and geothermal drilling operations.

e) All exemptions shall be forwarded to the CIWMB within seven days after the decision is issued.

[Comment: In exempting facilities, the EA should recognize that only facilities which are solid waste facilities, as defined in Public Resources Code section 40194, must obtain either a permit or an exemption. The following are examples of facilities that need not apply for an exemption or a permit:
1. A facility solely engaged in purchase or sale of salvaged separated materials.
2. Scrap metal, glass, cardboard and fiber brokers and manufacturing firms, which utilize salvaged materials.
3. Recycling centers that only handle salvaged separated materials for reuse.
4. Salvaged separated material collection, storage, or processing activities.]


.21565.5. CIWMB - Filing Requirements for Exemptions from Solid Waste Facility Permit (SWFP). (T14:§17616)
An applicant must file with the EA information containing applicable sections of a Report of Facility Information/Joint Technical Document (RFI/JTD) to establish that an exemption should be granted.

Article 2. CIWMB - Applicant Requirements.
.21570. CIWMB - Filing Requirements. (T14:§18201)
(a) Any operator of a disposal site who is required to have a full SWFP and waste discharge requirements pursuant to Public Resources Code, Division 31 and §20080(f) shall submit an application package for a solid waste facility permit in duplicate to the EA pursuant to .(f). The applicant shall also simultaneously submit one copy of the application form and the Joint Technical Document (JTD) to the Regional Water Quality Control Board (RWQCB). The applicant shall ensure demonstration of financial assurances to the CIWMB pursuant to Chapter 6 of this Subdivision.

(b) All other applicants who are required to have a full SWFP shall submit an application package for a SWFP in duplicate to the EA pursuant to .(f). The applicant shall also simultaneously submit one copy of the application form to the RWQCB.

(c) Any application package submitted to the EA shall be accompanied by the fee specified by the EA pursuant to PRC §44006(e).

(d) The application package shall require that information be supplied in adequate detail to permit thorough evaluation of the environmental effects of the facility and to permit estimation of the likelihood that the facility will be able to conform to the standards over the useful economic life of the facility. The application package shall require, among other things, that the applicant and the owner give the address at which process may be served upon them.

(e) All information in the application package shall be certified by the applicant and the owner of the site as being true and accurate to the best knowledge and belief of each. The applicant, owner of the facility, or both, shall supply additional information as deemed necessary by the EA.

(f) A complete and correct application package shall include, but not necessarily be limited to, the following items:
(1) Completed Joint Application Form (CIWMB E-1-77, Version 6-96, Appendix 4); and

(2) Complete and correct Report of Facility Information. In the case of disposal sites, this will be a Report of Disposal Site Information (RDSI) or a RDSI in the format of a JTD; and

(3) California Environmental Quality Act (CEQA) compliance information as follows:

(A) Evidence that there has been compliance with the CEQA, Division 13 (commencing with section 21000) of the Public Resources Code, regarding the facility; or

(B) Information on the status of the application's compliance with the CEQA regarding the facility, including the proposed project description. Once there has been compliance with the CEQA regarding the facility, evidence of compliance shall be submitted to the EA; and

(4) Any CEQA Mitigation Monitoring Implementation Schedule; and

(5) Conformance finding information, including one of the following:

(A) Until a countywide or regional agency integrated waste management plan has been approved by the CIWMB, the application shall include statements that: the facility is identified and described in or conforms with the County Solid Waste Management Plan, or otherwise complies with Public Resources Code section 50000; and that the facility is consistent with the city or county General Plan and compatible with surrounding land use, in accordance with Public Resources Code section 50000.5; or

(B) After a countywide or regional agency integrated waste management plan has been approved by the CIWMB, the application shall include a statement that: the facility is identified in either the countywide siting element, the non-disposal facility element, or in the Source Reduction and Recycling Element for the jurisdiction in which it is located; or, that the facility is not required to be identified in any of these elements pursuant to Public Resources Code section 50001; and

(6) For disposal sites, completeness determination of Preliminary or Final Closure/Postclosure Maintenance Plan (Subchapter 4 of this Chapter); and

[Note: The operator has the option of submitting the preliminary closure plan with the JTD. In which case the EA and RWQCB (and possibly the CIWMB if acting as the consultant for the EA for technical review) would review it at the same time. If deemed complete by the reviewing agencies, the permit application package could then be accepted for filing if all other information in the JTD is accepted by the EA. Or the operator can submit a stand alone preliminary closure plan to be deemed complete by reviewing agencies before the application package is submitted to the EA. For CIWMB purposes, all final closure/postclosure plans are stand alone documents but can be processed jointly with a proposed permit revision as long as the final plan is determined complete prior to approval of the proposed permit. The JTD Index prepared for the EA should show where each closure requirement is addressed in the closure/post-closure plan.]

(7) For disposal sites, current documentation of acceptable funding levels for Financial Assurance Mechanism (in accordance with Chapter 6, Division 2); and

(8) For disposal sites, current documentation of compliance with operating liability requirements in accordance with Chapter 6;

(9) Land Use and/or Conditional Use Permits.


History
1. Change without regulatory effect amending section filed 5-17-91 pursuant to section 100, title 1, California Code of Regulations (Register 91, No. 27).

.21580. CIWMB - Submittal of an Incomplete Application Package (T14:§18203)

The applicant may request, in writing, that the EA accept an incomplete application package. As a condition of acceptance, the applicant shall waive the statutory time limit contained in PRC §44008. The application package shall conform to section 21570 within 180 days from the date the EA agrees to accept the package as incomplete or

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the application package shall be rejected. Upon submittal of an incomplete package, the applicant shall list the deficiencies in the package, reasons for the incomplete submittal, and a proposed schedule as to when the deficiencies will be submitted.


21585. SWRCB - Joint Technical Document (JTD). (new)

Regulations in this section were promulgated by the State Water Resources Control Board (SWRCB), are administered by the appropriate Regional Water Quality Control Board (RWQCB) through the issuance of waste discharge requirements (WDRs) or other enforceable orders, and are applicable both to the RWQCB and to the owner or operator of a waste management unit (Unit) for the treatment, storage, or disposal of solid waste, in cases where the Unit is jointly regulated by the RWQCB and by one or more other state agencies.

(a) JTD Addresses All Post-CUP Permitting Agency Requirements — After July 18, 1997, for any Unit jointly regulated by the RWQCB and another state agency (or agencies), the report of waste discharge (ROWD) submitted to the RWQCB in support of the development or revision of WDRs for that Unit shall be in the form of a joint technical document (JTD) which includes all applicable information required under Article 4 of Subchapter 3 of this chapter (§21710 et seq.), in addition to all information necessary to support the development (or modification, as appropriate) and issuance of any state or local agency permits, other than the conditional use permit, that are required to operate the Unit (including but not limited to the lateral expansion of any Unit).

1) JTD Submittal Date — For new Units for which the ROWD is initially submitted (as part of the application for WDRs) after July 18, 1997, the discharger shall submit the ROWD in the form of a JTD when applying for WDRs for the Unit. For all other new Units and for existing Units, the discharger need not reorganize and resubmit, as a JTD, those portions of the ROWD submitted prior to July 18, 1997. For new and existing Units, after July 18, 1997, except for scheduled monitoring reports, each submission regarding the Unit, whether initiated by the discharger or requested by RWQCB, shall be made in the form of a separate addendum to the JTD, pursuant to (a)(4).

2) JTD Scope — The discharger is responsible for identifying all state and local agencies for which the JTD will serve as a joint permitting information document, pursuant to (a). Nevertheless, for a landfill, the list of agencies addressed in the JTD shall include at least the RWQCB, the CIWMB, the EA, and the AQMD or APCD.

3) Integration — The discharger is free to organize the JTD in any manner that maximizes the readability and compactness of the document. Nevertheless, to the extent feasible, with respect to any portion of the JTD that discusses a subject of regulatory concern to more than one agency, the discharger shall integrate the discussion to satisfy the concerns of all agencies concerned with that subject. Likewise, to the extent feasible, for facilities having more than one Unit, the JTD shall address topics which are germane to all Units at the facility (e.g., the hydrogeology of the facility and surrounding area) in a manner which integrates and incorporates all concerns applicable to each individual Unit and to the facility in general.

4) JTD Addenda — After July 18, 1997, each submittal made to any permitting agency encompassed by the JTD shall be in the form of a numerically-sequential addendum to the JTD (i.e., Addendum 76 would be followed by Addendum 77). For any given topic being addressed by a given addendum, the discharger shall send a copy of that addendum simultaneously to each permitting agency listing that topic in their agency-specific JTD Index, and shall include an updated JTD page listing for each Water Board JTD index line-item [under (b)] that is addressed by that addendum.

(b) Water Board (JTD) Index — As of July 18, 1997, each RWQCB shall make available to the discharger (both in hard copy and on magnetic media) a JTD index (Water Board Index) listing, by unique line-item number, each topic which the JTD must address to provide the RWQCB information needed to write and adopt or revise WDRs. For each line item (i.e., for each separately listed topic) in the Water Board Index, the discharger shall list all JTD pages (by page number or ranges thereof) addressing that topic. In cases where the preliminary or final closure and post-closure maintenance plan is submitted as a separable part of the JTD, as allowed by §21769(a), the component parts of the plan shall nevertheless be listed as part of the JTD index.
(c) Coordination — Upon the submittal of a new JTD or addendum, the RWQCB shall concentrate the initial review upon those line-items in the Water Board Index which are coded as being of joint interest with other agencies. Regarding all such joint-interest line-items in the Water Board Index, the RWQCB shall coordinate with staff from the other interested agencies, as appropriate, to ensure that WDRs (or proposed changes thereto) do not duplicate or conflict with the requirements of the other agencies.


Any operator of a disposal site which is required to submit a RDSI, closure/post-closure maintenance plan, and/or a ROWD or any other report that addresses similar regulatory concerns, may address those requirements under one JTD. The JTD will be used in place of the RDSI only if it meets all the requirements set forth in §21600 and lists where each requirement has been satisfied in the document in the form of a JTD index, pursuant to .(c).

(a) After July 18, 1997, any operator of an existing facility who submits an application package to the EA, pursuant to §21570, which proposes to change the facility's operations, or to change the SWFP shall do one of the following:

1) Submit the updated information as an amendment to the existing JTD along with, a JTD index as described in .(c), referencing the new or updated information; or

2) Submit a complete JTD as described in §21600 along with a JTD index as described in subsection c.

(b) After July 18, 1997, any operator of a new facility that submits an application package to the EA pursuant to §21570, shall submit a complete JTD pursuant to §21600, and an index of the topics addressed in the JTD to be used by the EA as described in .(c).

(c) As of July 18, 1997, the operator shall include with the JTD a copy of an index specifically for use by the EA. The page number or the first line number within the JTD which addresses the topic shall be noted next to that topic in the index. The EA shall make available to the operator either in hard copy and/or on magnetic media a JTD index listing, (Index found in Appendix 2) showing each topic which the JTD must address to provide the EA with relevant facility information for writing or revising the facility permit.

(d) These requirements do not apply to those facilities which have filed a ROWD or RDSI and application for SWFP prior to July 18, 1997. In the event the EA determines the application package for an RDSI first submitted prior to the effective date of these regulations to be incomplete, additional information requested shall be submitted as part of the RDSI and/or application for SWFP, as appropriate.


(T14:§17607,17616,17626,17628,17629,18222)

(a) In order to obtain a solid waste facility permit, each operator of a disposal site must file with the EA a RDSI as required in §21600 and §21590. The information contained in the RDSI shall be used to determine whether a permit should be issued and to provide information to be included within the permit if applicable. In order to maintain the permit, the operator must file amendments to the RDSI as required in §21665. Such amendments or lack thereof may become the basis for changes in the permit or for revocation of the permit. The submittal shall contain only those items listed in §21570(f) that have changed or otherwise specified by the enforcement agency.

(b) A RDSI shall contain the following:

1) General

(A) Facility Overview — Provide a statement including the name of the site, the name of the person who will operate the site, the name of the person who owns the land, and a description of the operation cycle.

(B) Site Plan — Provide facility plan(s), including the pre-disposal topography of the site, the facility boundary of the site (clearly illustrating parcels owned by the operator and/or any parcels leased), the total permitted acreage of the site, the acreage of the disposal area, fill sequencing and excavation plans, the extent of
any buffer zones between the disposal area and the permitted property boundaries provided by the facility layout, and the vertical limits of the site. The map required for a ROWD/JTD may be used for the RDSI providing all requirements of this subsection are met.

(C) Hours — State the hours and days of operation for the site, including but not limited to maintenance, site operation, receipt of waste, and public and commercial access.

(2) Waste Classification and Management
(A) Waste Types/Volumes — Describe the types of wastes accepted or proposed for acceptance. Estimated waste volumes should be presented, including current daily average and peak daily waste flows as well as a five year projected waste flow. Specific mention shall be made concerning the receipt of liquid, designated, special wastes or hazardous waste, if taken.

(3) Waste Management Unit Classification and Siting
(A) Airport Safety — Provide documentation that the Federal Aviation Administration and appropriate airport officials were notified if a new MSWLF unit or lateral expansion will be sited within a five-mile radius of any airport runway end used by turbojet or piston-type aircraft. Include results of the demonstration requirement, if required by §20270.

(B) Volumetric Capacity — Provide calculations for volumetric capacity of the site expressed in cubic yards, net permitted capacity available for waste disposal, including the amount of capacity consumed by soils used for liner construction, daily and intermediate cover, and final cover, if included in the total capacity given. Attach topographic maps, including the delineation of the site property boundary and the disposal area used for the volumetric calculations and the date of survey. This information shall be certified by a registered civil engineer or registered geologist.

(C) Site Life Estimate — Provide an estimate of the site life based on the capacity of the site and the waste flow projections, and assumptions regarding the compaction density used in life expectancy calculations. Include any other factors which may affect site life (e.g. local restrictions).

(D) Site Location — Describe the site location, referencing a location map highlighting the legal boundaries, points of access, and major access routes for waste deliveries to the site.

(E) Land Use — Describe and provide a plot plan showing land uses and land use zoning for all properties within 1000 feet of the facility boundary shown on a site plan. The site plan must show structures located on these adjacent properties or distances to the nearest structures. The plot plan shall include specific limits of the existing and planned disposal areas, in relationship to the surrounding land use.

(F) Ancillary Facilities — Describe and provide a plot plan showing all ancillary facilities at the site, including, but not limited to, administration buildings, entrance facilities, scales, maintenance structures, and hazardous materials storage areas.

(4) Design and Construction Standards for all Sites
(A) General Design Parameters — Describe how the site design accommodates or provides for the service area, climatological factors, physical setting, soils, drainage, and other pertinent information. The design shall be developed by a registered civil engineer or registered geologist. If the site is to be used by the general public, show how the design accommodates such use.

(B) Design Responsibility — Design of a new disposal site shall be under the direction of a registered civil engineer. The designer shall utilize expert advice as appropriate from persons competent in soils, hydrology, geology, landscape design, and other disciplines.

(C) Construction Sequencing Plans — Describe sequencing plans showing the anticipated phases of site development. A map showing the topographical contours prior to filling and the existing topographical contours of the permitted boundary.

(D) Grading Plan — Include a grading plan showing the proposed final elevations of the completed disposal site, and excavation depth, including existing and proposed borrow area.
(E) Gas Management Plan — The gas management plan shall include a description of the facility's gas control and monitoring systems. The site plan shall show locations of monitoring wells. The plan shall describe how the facility will comply with §20919 and §20919.5. Describe any possible use of landfill decomposition gases. Reference any additional information provided in the closure plans pursuant to Article 6.

(5) Operating Criteria
(A) Records — Describe the procedures for maintaining accurate records as required in §20510 and 20515.
(B) Security — Describe how the operator will discourage unauthorized access by persons or vehicles.
(C) Sanitary Facilities — Describe the sanitary facilities available to site personnel and the public.
(D) Communications Systems — Describe the communications systems utilized and emergency communications procedures followed at the site.
(E) Lighting — Describe the locations, numbers, and types of all permanent and portable lighting to assure safety of employees during nighttime operations, if applicable.
(F) Safety Equipment — List personal safety equipment used by operating and maintenance personnel.
(G) Personnel Requirements — state the minimum numbers and qualifications of personnel required for site operations, maintenance, environmental controls, records, emergency, and health and safety.
(H) Personnel Training — Describe the training required by the various personnel identified above and how that training is to be provided in order to comply with §20610.
(I) Supervisory Structure — Describe supervisory structure, including the management organization which will operate the site and the name of supervisor(s).
(J) Spreading and Compaction — Describe the equipment and methods used to spread and compact wastes.

(6) Cover
(A) Cover Materials — Provide a plot plan identifying cover material quantities required from on-site sources, excavation sequence of the site, alternative daily cover if applicable and stockpile locations if stockpiled for a significant amount of time. Identify or describe off-site sources or types of cover materials needed for a five year duration if not included in plot plan.
(B) Cover Frequency — State the cover frequency proposed or the alternative daily cover proposed for use in lieu of soil as daily cover. Provide information regarding compliance with §§20680 and 20685 if applicable.
(C) Intermediate Cover — Describe the operator's methods for placing intermediate cover on all areas of the landfill which have not received waste for an 180 day or more time frame.

(7) Handling
(A) Public Health Design Parameters — Disposal sites shall be designed in such a manner as to minimize the propagation or harborage of flies, rodents or other vectors, and the creation of nuisances by reason of solid wastes being deposited at the site. Other factors which shall be taken into consideration are air and water quality, noise control, odor control, public safety and other pertinent matters related to the protection of public health.
(B) Salvaging Activities — If salvaging activities are proposed, describe types of materials handled, and procedures to ensure that salvaging and other waste activities are conducted in a planned and controlled manner so they do not interfere with other aspects of site operation. Provide an EA approved list of items which the facility is permitted to salvage. Describe the storage area for salvaged materials generated on-site or imported. Describe the procedures to ensure that salvage is removed at a frequency which will prevent health or fire problems.
(C) Volume Reduction Activities — If volume reduction activities such as bailing and shredding are proposed, describe procedures to ensure proposed operations are conducted in a controlled manner so that they do not interfere with proper construction and maintenance of the site, and do not create health, safety or environmental problems.
(D) Equipment — Describe the minimum equipment requirements necessary to assure ongoing compliance with the state minimum standards. List on-site equipment designated as standby, or provide an up-to-date list of

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firms or agencies which can supply replacement units within a period of time short enough to ensure compliance with all regulatory requirements. Describe preventative maintenance activities for the equipment listed above.

(E) Waste Handling — Describe dimensions of unloading area and unloading practices. Include procedures for handling, unloading and disposal of liquid waste, special waste, or hazardous waste, if accepted.

(G) Litter — Describe the collection frequency for controlling litter and windblown materials in order to prevent the accumulation of quantities which cause a public nuisance or other problems. Include the litter control method used, i.e. litter fences, litter crews, etc.

(H) Noise — Describe the methods for ensuring that noise from site operations are controlled to prevent nuisance to persons using the site and nearby residents.

(I) Traffic — Describe the traffic control plan, showing that the traffic flow into, on, and out of the site is controlled to minimize interference and safety problems for traffic on-site and adjacent public streets or roads.

(J) Hazardous Waste — Describe in detail the hazardous waste screening program.

(9) Compilation of approvals — Provide a list of all approvals having jurisdiction over the disposal site.


.21610. CIWMB - Amendments to Application Package. [T14:§18202(a)]

At any time after the application package has been submitted and before issuance or denial of the permit or alteration thereof, the applicant shall promptly notify the EA of any changes in any of the information required in the application package. Such notice shall be given by filing two copies of the amendments to the application within seven days of the applicant's first knowledge of the changes. For processing additions, revisions or amendments to the proposed permit and accompanying documents, refer to section 21685(d).


.21615. CIWMB - Completeness Appeal. [T14: §18203(f)]

If an application is determined not to be complete, the applicant may appeal the decision to the EA within fifteen (15) days of the date of notification. Such an appeal must be in writing and specify the grounds for the appeal. A final written determination on the appeal shall be made by the hearing panel designated pursuant to Public Resources Code §§44308 or 44309, whichever is applicable, no later than 60 days after the EA's receipt of the applicant's appeal.

.21620. CIWMB - Change in Operation. (new)
(a) Any applicant proposing to make a significant change in the design or operation of the facility shall file an amendment to the RFI with the EA at least 150 days prior to the proposed change unless otherwise determined by the EA.

(b) RFI or amendments to the RFI shall be accompanied by an application form. All amendments shall be submitted as specified in §21570. The applicant shall only submit those items listed in §21570(f) that have changed or are proposed to change, unless otherwise specified by the EA. Such amendments or lack thereof may become the basis for changes in the permit as determined by the EA as described in §21665. The operator shall have the right to appeal the EA's decision before the hearing panel.

(c) If the change in operation does not meet the requirements of §21665(c), the operator shall submit an application package for revision pursuant to §21570 and be processed by the EA pursuant to §21650.


.21630. CIWMB - Change of Owner, Operator, and/or Address. (T14:§18216 & 18217)
(a) Owners and/or operators of a facility who plan to sell, encumber, transfer or convey the ownership or operation of the facility or land to a new owner or operator, or who plan to change their current address shall notify the EA and the CIWMB 45 days prior to the anticipated transfer. [Note: Although it is similar to the previous requirement for a change in owner, this significantly reduces the requirements for incorporating a new operator into the SWFP.] This notification shall include names, address(es), where notice can be sent and phone number(s) of the new owner/operator.

(b) The anticipated owner/operator shall provide the following:

1. Documentation that the anticipated owner/operator meet the financial assurance and operating liability requirements.

2. A signed affidavit certifying that the anticipated owner/operator has read the governing permit and conditioning documents and will operate in accordance with the existing SWFP terms and conditions and conditioning documents and that all new information submitted is correct.

3. Amendments to the RFI which reflect the change in owner/operator or address.

(c) any information provided pursuant to (a) shall not be a matter of public record and shall be considered confidential information until such time as the owner encumbers, sells, transfers, or conveys the property.

(d) Every applicant for a permit, every operator of a solid waste facility, and every owner of property on which a facility is located shall notify the EA and the CIWMB of each change of address. Notice shall be given within seven days after the change is effective and shall be given on a form specified by the CIWMB.


.21640. CIWMB - Review ofPermits. (T14:§18213)
(a) Except as provided in §21680, all full SWFPs shall be reviewed and, if necessary, revised, from the date of last issuance at least once every five years.

(b) No less than 150 days before the permit is due for review, the operator shall submit an application for permit review. The application shall be made in the manner specified in §§21570 and 21590 and shall contain the following:

1. Identify the proposed changes in design and operation; and

2. updated amendments to the Report of Facility Information (RFI);

3. for disposal sites only, the updated amendments shall include an estimate of the remaining site life and capacity.
Article 3. CIWMB - Enforcement Agency (EA) Requirements

21650. CIWMB - EA Processing Requirements. (T14§18203)

(a) Upon its receipt, the EA shall stamp the application package with the date of receipt. The EA shall examine the application package to determine whether it meets the requirements of §21570. If the EA finds the package meets the requirements of §21570, the application package shall be accepted and stamped with the date of acceptance. Notwithstanding any other provision of this division, the application package shall be deemed filed on the date of acceptance.

(b) The EA shall either accept or reject the application package within thirty days of its receipt.

(c) Within five days of filing, the EA shall notify the CIWMB, and the RWQCB if applicable, of its determination. The EA shall submit as its notification to the CIWMB a copy of the accepted application form. The EA shall also forward a copy of the application form to the RWQCB if applicable.

(d) If the EA determines that the application package does not meet the requirements of §21570, it shall reject and not file the application, and it shall, within five days of determination, so notify the applicant, the CIWMB, and the RWQCB if applicable, enumerating the grounds for rejection. The EA shall include in its notification to the CIWMB a copy of the rejected application form. The application package, together with the notice of rejection, shall be kept in the EA's file.

(e) Upon request of the applicant, the EA may accept an incomplete application package. As a condition of acceptance, the enforcement agency shall waive the statutory time limit contained in the Public Resources Code Section 44009. [Note: Section 21580 is the section for processing the applicant's waiver of timeframes.] The EA shall notify the applicant within 30 days if the applicant's request for review under this subsection has been accepted. If the application package does not conform with the requirements of §21570 within 180 days from the date of the EA agreeing to accept the package as incomplete the EA shall reject the application package, pursuant to .(d). If the EA finds the application package meets the requirements of §21570, the application package shall be accepted pursuant to .(c).

(f) No later than 55 days after the application package has been filed, the EA shall mail to the CIWMB the following:

1. A copy of the proposed permit;
2. The accepted application package;
3. A certification from the EA that the permit application package is complete and correct, including a statement that the RFI meets the requirements of §§16600, 14CCR 14711 or 15763.
4. Documentation, if applicable, of the applicant's compliance with any RWQCB enforcement order or the status of the applicant's WDRs, as described in PRC §44009.
5. Any written public comments received on a pending application. Subsequent to the transmittal of the proposed permit, the EA shall, within five (5) days of receipt, provide a copy of any additional written public comments to the CIWMB.
6. A permit review report which has been prepared pursuant to §21675, within the last five years.
7. EA finding that the proposed permit is consistent with and is supported by existing CEQA analysis, or information regarding the progress toward CEQA compliance.
8. A copy of the proposed permit to the CIWMB, the EA shall submit a copy of the proposed permit to the applicant, the RWQCB if applicable, and any person so requesting in writing. The copy of the proposed permit provided to the applicant shall also be accompanied by a form for request for hearing, which the applicant may use to obtain a hearing before a hearing panel to challenge any condition in the permit. In cases
where a hearing panel may be requested, the EA shall notify the CIWMB within seven days of being noticed by the operator.

(h) The proposed permit shall contain the conditions the EA proposes to include in the permit. The proposed permit shall not contain conditions pertaining solely to air or water quality, nor shall the conditions conflict with conditions from WDRs issued by the RWQCB.

[Note: The process to obtain a full SWFP might not include the RWQCB if the facility is other than a landfill or disposal site. Therefore, EA submittals of forms and documents to the RWQCB will be made if applicable to the type of facility.]


.21655. CIWMB - Amendments to Application Package. [T14:§18202(b)(c)]

(a) If the EA determines that the amendment submitted pursuant to 21610 fundamentally alters the nature of the application, which requires evaluation, within twenty days of the filing of the amendment, the EA may deem the amendment a new application. This amendment will supersede the previous application and incorporating unamended portions of the previous application, in which case the time for the EA to act on the amendment shall be computed from the date of filing of the amendment. Any such determination by the EA shall be documented within five days of the determination by written notice to the applicant.

(b) If the amendment is submitted to the EA eleven days or more after the date the EA has stamped the package as received, the 30 day review period may be extended as long as the EA still complies with .(a).


.21660. CIWMB - Public Notice and Comment; Recordkeeping Requirements. (T14:§18204)

(a) The EA shall maintain a current list of all pending applications at its offices. The list shall be publicly available during normal business hours.

(b) The EA shall mail written notice of an application to every person who has submitted a written request for such notice.

(c) Written public comments on an application shall be retained by the EA.


.21663. CIWMB - Issuance of Permit. (T14:§18208)

(a) Upon compliance with the CEQA and this article, and upon the concurrence of the CIWMB, the EA shall issue the permit as provided in Public Resources Code section 44014. The permit shall specify the person authorized to operate the facility and the boundaries of the facility. The permit shall contain such conditions as are necessary to specify a design and operation for which the applicant has demonstrated in the proceedings before the EA the ability to control the adverse environmental effects of the facility.

1. As used herein, “design” means the layout of the facility (including numbers and types of fixed structures), total volumetric capacity of a disposal site or total throughput rate of a transfer/processing station, transformation facility, or composting facility; vehicular traffic flow, and patterns surrounding and within the facility, proposed contouring, and other factors that may be considered a part of the facility’s physical configuration.

2. As used herein, “operation” means the procedures, personnel, and equipment utilized to receive, handle and dispose of solid wastes and to control the effects of the facility on the environment.

21665. CIWMB - Processing Report of Facility Information (RFI) Amendments. (new)
(a) The applicant shall submit an RFI amendment and application package pursuant to §21570 and §21600, or 14 CCR §18221.5, 18221.6, or §17863 to the EA. The submittal shall contain only those items listed in §21570(f) that have changed, are proposed for change or as otherwise specified by the EA.
(b) the EA shall review the applicant's amendments to the RFI and determine if such amendments or lack thereof are the basis for changes in the permit.
(c) The EA may approve and file the amendment to the RFI without revising the permit if all of the following criteria are met:
(1) the proposed change is consistent with all applicable certified and/or adopted CEQA documents, or has been determined by the EA that the change would not create any adverse environmental impacts and is exempt from the requirements of CEQA;
(2) the EA has deemed the proposed change acceptable and consistent with, but not limited to, state minimum standards pursuant to Chapter 3 of this subdivision or applicable minimum standards in Title 14 (commencing with §17200), and including financial assurances and operating liability criteria pursuant to Chapter 6 of this subdivision if applicable; and
(3) the changes do not conflict with the terms and conditions in the current SWFP.
(d) The EA shall determine if the RFI amendments meet the requirements of (c) within 30 days of receipt.
(e) Within 5 days of acceptance for filing of the RFI amendment and application package, the EA shall notify the operator, the CIWMB and the RWQCB of their determination. The EA shall include in their notification to the CIWMB, a copy of the amended RFI, and a copy of the application form along with the EA determination specified in (d).
[Note: Submittal of an Application Form in (e) is for tracking purposes.]
(f) In cases where amendments do not follow the criteria set in this section, the EA may either require the operator to revise the SWFP pursuant to §21570, or deny the proposed amendment, in which case the applicant shall have thirty (30) days within which to appeal the decision to the hearing panel.

21670. CIWMB - Change of Owner Operator, and/or Address. (T14:§18216 and 18217)
(a) The EA shall review the submitted notification prescribed in §21630 and any available records to determine if the current and anticipated operators/owners have provided the required information and that the facility is and will be able to operate within the terms and conditions of their permit and RFI. If the anticipated operator/owner has satisfied all of the requirements and the EA has obtained a written confirmation from the CIWMB that the anticipated owner/operator has complied with PRC §43040 and §43600, the EA shall notify the operator and CIWMB within 30 days of receipt of the notification. Then, the EA has 15 days (from informing the operator and CIWMB that the notification was adequate) to send the operator and CIWMB a copy of the changed permit, to reflect the changes in the name of the owner, operator and/ or facility name. This section does not authorize the EA to change any other aspect of the SWFP, including the issuance date or permit review date.
(b) If the EA determines that the operator/owner has not provided adequate documentation or if the EA has reason to believe that the anticipated operator or owner will be operating outside the terms and conditions of the governing SWFP, the EA shall inform the operator and the CIWMB, in writing, within 30 days of receipt of the notification. The EA shall provide the basis for the notification being deemed inadequate.
(c) Any information provided pursuant to (a) shall not be a matter of public record and shall be considered confidential until such time as the owner's encumbering, selling, transferring, or conveying of the property, occurs.
(d) This action will not take the place of a permit review or revision pursuant to §§21620 or 21640.
(e) Every operator of a solid waste facility, and every owner of property on which a facility is located shall notify the EA and the CIWMB of each change of address. The EA shall keep this information on file.


.21675. CIWMB - Review of Permits. (T14:§18213)

(a) Except as provided in §21680, all full SWFPs shall be reviewed and if necessary revised, from the date of last issuance at least once every five years. The EA shall give the operator notice of the five year review no less than 180 days before it is due.

(b) The EA shall review the operator's submittal in accordance with §21640 and prepare a permit review report.

(1) The permit review report shall include documentation that the following have been reviewed: the operator's submittal pursuant to §21640(b), the current permit and conditioning documents, all RFI amendments since the last permit review, the CEQA, and any other information in the record to identify any changes.

(2) The permit review report shall determine any actions required by the operator.

(c) A copy of the permit review report shall be submitted to the CIWMB within 150 days from receipt of the application for permit review.


.21680. CIWMB - Reinstatement of Suspended and Revoked Permits. (T14:§18212)

(a) If a permit has been suspended, it is reinstated without further action on the date specified in the suspension or upon completion of specified acts. A suspended permit shall be due for review five years after its original issuance or last review or revision, including the period of suspension.

(b) If a permit has been revoked, it may be reinsatated by application, no less than one year after the effective date of the revocation and no less than one year after any similar application. Such an application shall be made in the manner specified in §21570 and shall be handled in the same manner as an application for a new permit; however, nothing in this section is intended to prevent the EA, hearing panel, or CIWMB from considering the revocation and grounds therefor in reviewing the application. A permit reinstated after revocation shall be due for review five years after its reinstatement.

(c) No less than one year after the effective date of the revocation and no less than one year after any similar petition, a person whose permit has been revoked may petition the EA for reduction of the penalty. If the petition is denied, the person is entitled to a hearing before the hearing panel.

[Comment: Suspension of a permit is a punitive or remedial action not intended to deprive the permit holder indefinitely of the right to operate. Revocation of a permit, a more severe action, closes the facility for at least one year, at the end of which the holder of the revoked permit may apply for reinstatement in the same manner as one applies for a permit for a new facility.]


Article 3.1. CIWMB - CIWMB Requirements

.21685. CIWMB - Proposed Permit; CIWMB Processing Requirements. (T14:§18207, §17608)

(a) The CIWMB shall stamp the proposed permit with the date of receipt at the time the envelope is opened. The CIWMB shall consider each proposed permit, any public testimony, and comments. Written comments may be submitted to the CIWMB and will become part of the CIWMB record. Such written comments shall be made available to the EA.

(b) The CIWMB shall not concur in issuance of the proposed permit if the following information, if applicable, has not been submitted to the EA and the CIWMB pursuant to PRC §44009:

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(1) complete and correct Report of Facility Information as certified by the EA,

(2) EA’s Permit Review Report pursuant to §21675,

(3) EA’s proposed permit written pursuant to this Subchapter.

(4)(A) Information that the facility is identified and described in or conforms with the County Solid Waste Management Plan (PRC §50000); and that the facility is consistent with the city or county General Plan and compatible with surrounding land use, in accordance with PRC §50000.5; or

(B) After a countywide or regional agency integrated waste management plan has been approved by the CIWMB, the EA’s finding that the facility has met the requirements of PRC §50001.

(5) Documentation that a Preliminary or Final Closure/Postclosure Maintenance Plan has been deemed complete, if applicable;

(6) Land Use and/or Conditional Use Permits;

(7) (A) Current documentation of acceptable funding levels for Financial Assurances Documentation in accordance with Chapter 6, if applicable; and

(B) Current documentation of compliance with Operating Liability Requirements, if applicable (Chapter 6).

(8) The CIWMB shall ensure the facility is operating consistent with State Minimum Standards, pursuant to Subchapter 4 of Chapter 3 of this subdivision or applicable minimum standards in Title 14 (17200 et seq.),

(9) The EA finding that existing CEQA documentation is consistent with and supports the proposed permit and RFI or supporting information indicating the EA has found that approval of the proposed permit would not lead to any adverse environmental impacts and is exempt from the requirements of CEQA.

(c) The CIWMB shall either concur or object to the issuance of the proposed permit within sixty days of receipt, except as authorized by PRC §44009, or by operator’s consent. If the CIWMB objects to a proposed permit, it shall accompany its objection with an explanation of its action, which may suggest conditions or other amendments that may render the proposed permit unobjectionable; however, such suggestions do not constitute approval of the proposed permit subject to incorporation of the suggestions.

(d) If an applicant or enforcement agency requests that revisions, additions or amendments be considered, these will be considered in accordance with the conditions specified in §21580 and Subsection (c) of §21650 respectively.


§21686. CIWMB - Change in Owner/Operator and/or Address. (new)

Within 20 days of receipt of the notification pursuant to §21630, the CIWMB shall provide a written determination of the adequacy of the financial assurances and operating liability.


**Article 3.2 CIWMB - Other Requirements**

§21690. CIWMB - Report of Woodwaste Disposal Site Information. [Reserved]
Article 4. SWRCB - Development of Waste Discharge Requirements (WDRs)

21710. SWRCB - Report Of Waste Discharge (ROWD) and Other Reporting Requirements. [C15: §2590]

(a) General — Any person discharging or proposing to discharge solid waste to land where water quality could be affected as a result of such discharge shall submit to the RWQCB a report of waste discharge (ROWD), unless the report is waived by the RWQCB; nevertheless, the RWQCB shall not waive the report for any MSW landfill subject to regulation under SWRCB Resolution No. 93-62. After July 18, 1997, any person proposing to discharge solid waste at a waste management unit (Unit) that is subject to regulation by both the CIWMB/EA and the RWQCB shall make all ROWD submittals (including updates to a previously submitted ROWD) in the form of a Joint Technical Document (JTD), as provided in §21585. After July 18, 1997, this reporting requirement also applies to the expansion of the RWQCB-Permitted Area of a new or existing Unit and to the development of new Units at an existing facility. Dischargers shall submit any applicable information required by this article to the RWQCB upon request. Dischargers shall provide information on waste characteristics, geologic and climatologic characteristics of the Unit and the surrounding region, installed features, operation plans for waste containment, precipitation and drainage controls, and closure and post closure maintenance plans as set forth in §§21740, 21750, 21760, and 21769. For non-MSW Class III landfills, the RWQCB can waive the submittal of information it deems unnecessary to rendering a decision on the issuance of appropriate WDRs.

(1) [Reserved.]

(2) Final Closure/Post-Closure Plan — For Class II and III Units, a Final Closure and Post Closure Maintenance Plan shall be submitted with the closure notice required by (c)(5), unless, for landfill Units, the CIWMB requires submittal at an earlier date.

(3) Waiving Post-Closure Maintenance — The RWQCB can waive the post closure portion of the report if the discharger successfully completes clean-closure pursuant to §21090(f) [for landfills], §21400(b)(1) [for surface impoundments], or §21410(a)(1) [for waste piles], or if the RWQCB finds that post closure maintenance is not necessary to prevent adverse impacts on waters of the state; provided that the RWQCB shall not waive post closure maintenance for an MSW landfill subject to SWRCB Resolution No. 93-62 unless the Unit has been clean-closed. [Note: see also §21900 for corresponding CIWMB requirements.]

(4) Notification of Change — The discharger shall notify the RWQCB of changes in information submitted under the applicable SWRCB-promulgated requirements of this division, including any material change in: the types, quantities, or concentrations of wastes discharged; site operations and features; or proposed closure procedures, including changes in cost estimates. The discharger shall notify the RWQCB a reasonable time before the changes are made or become effective. No changes shall be made without RWQCB approval following authorization for closure pursuant to the site closure notice required by (c)(5).

(5) Construction Quality Assurance Plan (CQA Plan).

(A) Submittal (new Units) — For Units constructed (or reconstructed) after July 18, 1997, the discharger shall submit a preliminary CQA Plan as an integral or separable part of the initial ROWD/JTD under (a). The discharger shall make such changes to the CQA Plan as may be necessary to maintain continued compliance with §§20323 and 20324 (e.g., in the event of design changes, or as directed by the RWQCB). For a revised CQA Plan, the discharger shall submit the revised portions of the plan at least two weeks before beginning construction of any liner system or cover system.

(B) Submittal (existing Units) — For existing Units that do not have a CQA Plan meeting all the foregoing requirements, the discharger shall submit such a plan, or submit suitable modifications to an existing plan, prior to constructing, installing, or modifying any engineered feature at the Unit. In the absence of such construction, installation, or modification, the discharger shall make this submittal as part of whichever of the following documents is submitted first:

1. the final closure and post-closure plan under (a)(2); or
2. in the event that a release is discovered, as part of the proposed corrective action program under §20425(d).

(b) ROWD/WDR Out-Of-Date or Nonexistent — Dischargers who own or operate a new or existing Unit which has not been classified under previous versions of these regulations, or for which the discharger has not submitted a report of waste discharge (ROWD) before July 18, 1997, shall notify the RWQCB of the existence of their Unit prior to July 18, 1998, and shall submit a ROWD which complies with (a) before July 18, 1999, together with the appropriate filing fee. Dischargers who own or operate an existing Unit for which WDRs were last revised before November 27, 1984, shall submit a ROWD which complies with (a) to the RWQCB, together with the appropriate filing fee, on request.

(c) Notification.

(1) Change of Ownership — The discharger shall notify the RWQCB in writing of any proposed change of ownership or responsibility for construction, operation, closure, or post closure maintenance of a Unit. This notification shall be given prior to the effective date of the change and shall include a statement by the new discharger that construction, operation, closure, and post closure maintenance will be in compliance with any existing WDRs and any revisions thereof. The RWQCB shall amend the existing WDRs to name the new discharger.

(2) Response to Failure — The discharger shall promptly notify the RWQCB of any slope failure, occurring at the Unit. The discharger shall promptly correct any failure which threatens the integrity of containment features or the Unit, after approval of the method, in accordance with a schedule established by the RWQCB.

(3) Leachate Production Change Notification — The discharger shall notify the RWQCB within seven days if fluid is detected in a previously dry leachate collection and removal system or unsaturated zone monitoring system, or if a progressive increase is detected in the volume of fluid in a leachate collection and removal system.

(4) Monitoring Reports and Notifications — The discharger shall comply with the notification (and other submittal) requirements in Article 1, Subchapter 3, Chapter 3 of this division (§20380 et seq.).

(5) Notification of Closure.

(A) Landfills — For landfills subject to the CIWMB-promulgated regulations of this division, the discharger shall notify the RWQCB that the Unit is to be closed, and shall provide such notice either at the same time as for the CIWMB, under §21110, or 180 days prior to beginning any final closure activities (for the entire Unit or portion thereof), whichever is sooner.

(B) Other Units — For Units not subject to the CIWMB-promulgated regulations of this division, the discharger shall notify the RWQCB of Units to be closed at least 180 days prior to beginning any final closure activities, unless the RWQCB specifies a shorter interval in the WDRs for such a Unit.

(C) Affirmation — The notice provided pursuant to (c)(5)(A or B) shall include a statement that all closure activities will conform to the most recently approved closure plan and that the plan provides for site closure in compliance with all applicable federal and state regulations.

(6) Closure Completion Notice — The owner or operator of a Unit shall notify the RWQCB within 30 days after the completion of all closure activities for a Unit (or portion thereof, in the case of a landfill undergoing incremental closure under §21090(b)(1)(D)). The discharger shall certify under penalty of perjury that all closure activities were performed in accordance with the most recently approved final closure plan and in accordance with all applicable regulations. The discharger shall certify that closed Units shall be maintained in accordance with an approved post closure maintenance plan unless post closure maintenance has been waived pursuant to (a)(3).

(d) Appropriate Professional — Any report submitted under this section or any amendment or revision thereto which proposes a design or design change (or which notes occurrences) that might affect a Unit's containment features or monitoring systems shall be approved by a registered civil engineer or a certified engineering geologist. NOTE: Authority cited: Section 1058, Water Code. Reference: Sections 13172, 13260 and 13267, Water Code; Section 43103, Public Resources Code.
21720. SWRCB - Waste Discharge Requirements (WDRs). (C15: §2591)

(a) WDR Scope & Purpose — The RWQCB shall adopt waste discharge requirements (WDRs) that implement the applicable provisions of this title.

(b) WDR Revision — The RWQCB shall revise WDRs as necessary to implement the provisions of this title.

(c) Reclassification — Unit classifications and WDRs for existing Units shall be fully reviewed in accordance with schedules established by the RWQCB. The WDRs shall be revised to incorporate reclassification and retrofitting requirements as provided in §20080(e) and §20310, and to comply with applicable monitoring and response programs required under Article 1, Subchapter 3, Chapter 3 of this division (§20380 et seq.). The RWQCB shall specify in WDRs the schedule for retrofitting of existing Units. All retrofitting shall be complete within five years from the issuance of the revised WDRs.

(d) Local Agencies — WDRs for new Units or for expansion of Units beyond the RWQCB-Permitted Area on July 18, 1997, shall not be effective until the RWQCB is notified that all local agencies with jurisdiction to regulate land use, solid waste disposal, air pollution, and to protect public health have approved use of the site for discharges of waste to land.

(e) Consolidation of Requirements at Multi-Unit Facilities — At the discretion of the RWQCB, WDRs for all Units in a single facility can be combined into a single set of WDRs applicable to the facility as a whole and to each respective Unit within the facility, but only if the requirements that apply to each respective Unit are clearly identified. Likewise, the RWQCB can consolidate the requirements relating to precipitation and drainage control systems for two or more adjacent Units, provided that such consolidated requirements reflect standards for the highest classification of Unit involved. Each solid waste Unit at a facility shall have its own respective monitoring program(s) under Article 1, Subchapter 3, Chapter 3 of this division (§20380 et seq.); nevertheless, Units can share Monitoring Points, Background Monitoring Points, sampling efforts, and reporting periods to the degree that the RWQCB concurs that such sharing does not interfere with achieving the goal of the monitoring program(s) at each respective Unit.

(f) Records — The discharger shall be required to maintain legible records of the volume and type of each waste discharged at each Unit and the manner and (for Units other than surface impoundments) location of discharge. Such records shall be on forms approved by the SWRCB or RWQCB and shall be maintained at the waste management facility until the beginning of the post closure maintenance period. These records shall be available for review by representatives of the SWRCB and RWQCB at any time during normal business hours. At the beginning of the post closure maintenance period, copies of these records shall be sent to the RWQCB.


21730. SWRCB - Public Participation. (C15: §2592)

(a) Notification Of Interested Parties — To ensure adequate public participation in any RWQCB proceeding relating to land disposal of wastes, the following persons and entities shall receive individual notice of any public hearing or board meeting either involving the classification of Units or involving the issuance or revision of WDRs for classified Units subject to this division:

(1) the discharger and responsible public agencies;

(2) news media serving the county as well as communities within five miles of the Unit;

(3) citizens groups representing local residents;

(4) environmental organizations in affected counties;

(5) interested industrial organizations; and

(6) for an MSW landfill at which a release has migrated beyond the facility boundary, any persons requiring notification pursuant to SWRCB Resolution No. 93 62 [see 40CFR258.55(g)(1)(iii)].
(b) Notice Requirements — Notice of hearings or meetings related to Units, or to discharges subject to this division, shall be given not less than 45 days before the meeting at which such actions will be taken, and copies of the agenda package shall be available not less than 30 days before the meeting. Nevertheless:

(1) enforcement actions involving releases of hazardous wastes can be taken at meetings which comply only with the shorter (10-day) notice requirements of the California State Body Open Meetings Act; and

(2) emergency actions [as described in §647.2(d) Government Code)] taken by the RWQCB are exempt from public participation and notice requirements.

(c) Public Input Regarding a Proposed Corrective Action Program — Regarding the adoption of corrective action measures for an MSW landfill, including any hearing preparatory to such adoption, the RWQCB shall meet the federal requirements incorporated by reference into SWRCB Resolution No. 93-62 [i.e., see §258.56(c & d) and §258.57 of 40CFR258].


.21740. SWRCB - Waste Characteristics. (C15: §2594)

(a) ROWD To Include — Dischargers shall provide in the report of waste discharge (“ROWD,” including any such report that is integrated into a Joint Technical Document, pursuant to §21750) the following information about the characteristics of wastes to be discharged at each waste management unit (Unit) addressed by the ROWD.

(1) Constituents & Reference Numbers — A list of the types, quantities, and concentrations of wastes proposed to be discharged at each Unit. Wastes and known waste constituents shall be specifically identified according to the most descriptive nomenclature. A listing of all anticipated hazardous constituents that could be discharged to the Unit (e.g., household hazardous waste discharged to an MSW landfill might include constituents listed in Appendix II to 40CFR258); where available, this listing shall include constituent (or waste) reference numbers from listings established by DTSC or USEPA (e.g., Appendix IX to §65264 of Title 22 of this code).

(2) TSD Methods — A description of proposed treatment, storage, and disposal methods.

(3) Expected Decomposition Products/Rate — An analysis of projected waste decomposition processes for each Unit indicating intermediate and final decomposition products and the period during which decomposition will continue following discharge.


.21750. SWRCB - Waste Management Unit (Unit) Characteristics and Attributes to be Described in the ROWD. [C15: §2595 & §2547(a) // T14: §17777, §18260, §18263, & §18264]

(a) Identify Potential Impairment — Dischargers shall provide in the report of waste discharge (“ROWD”, including any such report integrated into a Joint Technical Document (JTD), pursuant to §21585) an analysis describing how the ground and surface water could affect the Unit and how the Unit, including how any waste, if it escapes from the Unit, could affect the beneficial uses of ground water bodies (including, but not limited to, any aquifers underlying the facility) and surface water bodies. The RWQCB shall use this information to determine the suitability of the Unit with respect to ground water protection and avoidance of geologic hazards and to demonstrate that the Unit meets the classification criteria set forth in Article 3, Subchapter 2, Chapter 3, Subdivision 1 of this division (§20240 et seq.).

(b) Support Proposed Classification — Dischargers shall provide the data required by this section regarding the physical characteristics of the Unit and the surrounding region in order to demonstrate suitability for the appropriate Unit classification. The ROWD shall present this information in understandable written, tabular, and graphic format, as appropriate, and this information shall be at a level of detail appropriate to support the RWQCB’s approving the Unit’s proposed classification. Maps, plans, diagrams, and other graphics shall be
(2) **Materials** — A description of natural geologic materials in and underlying the location of both the Unit and its surroundings, including identification of each rock's type, relative age, distribution and dimension features, physical characteristics, special physical or chemical features (e.g., alteration other than weathering), distribution, the extent of any weathered zones, susceptibility to natural surface near-surface processes, and all other pertinent lithologic data, all in accordance with current industry-wide practice [e.g., California Division of Mines and Geology's (CDMG's) Note 44 “Guidelines for Preparing Engineering Geologic Reports” (April, 1986)].

(3) **Geologic Structure** — A description of the natural geologic structure of materials underlying the location of the Unit and its surroundings, including: the attitude of bedding (if any); thickness of beds (if any); the location, attitude, and condition (tight, open, clay- or gypsum-filled, etc.) of any fractures; the nature, type (anticlinal, synclinal, etc.) and orientation of any folds; the location (surface and subsurface), age, type of surface displacement, attitude, and nature [e.g., aperture, amount of brecciation, degree of alteration and type of alteration products (tight, gouge-filled, etc.)] of any faults; and all other pertinent, related structural data, (all of the foregoing) in accordance with current industry-wide practices [e.g., CDMG’s Note 42 “Guidelines to Geologic/Seismic Reports” (May, 1986), and CDMG Note 49 “Guidelines for Evaluating the Hazard of Surface Fault Rupture” (May, 1986)].

(4) **Engineering and Chemical Properties** — The results of a testing and estimation program, carried out by a registered civil engineer or certified engineering geologist, as needed to formulate and support detailed site design criteria, including:

(A) determination of engineering and chemical properties of geologic materials underlying and surrounding the Unit, and of the Unit’s containment structure components (i.e., liner, LCRS, and final cover components);

(B) determination, or estimation, of the engineering and chemical properties of the waste and other layers placed, or to be placed, within the Unit.

(5) **Stability Analysis** — A stability analysis, including a determination of the expected peak ground acceleration at the Unit associated with the maximum credible earthquake (for Class II waste management units) or the maximum probable earthquake (for Class III landfills). This stability analysis shall be included as part of the ROWD (or JTD) for the proposed Unit, and an updated stability analysis (if the original analysis no longer reflects the conditions at the Unit) shall be included as part of the final closure and post-closure maintenance plan. The methodology used in the stability analysis shall consider regional and local seismic conditions and faulting. Data and procedures shall be consistent with current practice and shall be based on an identified procedure or publication. The stability analyses shall include modifications to allow for site specific surface and subsurface conditions. The peak ground acceleration so determined shall be the stability and factors of safety for all embankments, cut slopes, and associated landfills during the design life of the unit. For landfills and for waste piles and surface impoundments closed as landfills, final cover slopes shall be designed in compliance with the slope requirements of §21090.

(A) The stability analysis shall ensure the integrity of the Unit, including its foundation, final slopes, and containment systems under both static and dynamic conditions throughout the Unit’s life, closure period, and post-closure maintenance period. The stability analysis shall include:

1. the method used to calculate the factors of safety (e.g., Bishop’s modified method of slices, Fellinius circle method, etc.);

2. the name of any computer program used to determine the factors of safety, and

3. a description of the various assumptions used in the stability analyses (height of fill, slope and bench configuration, etc.).

(B) The stability analysis shall address all portions of the Unit and its immediate surroundings that are located in areas subject to liquefaction or unstable areas with poor foundation conditions, as identified either in the ROWD or in the Seismic Safety Element of the County General Plan, and shall address all portions of the Unit that incorporate geosynthetic liners as part of the Unit foundation or containment system (including the final cover).

(C) The stability analysis shall be prepared by a registered civil engineer or certified engineering geologist. Except as otherwise provided in .(f)(3)(D), the report must indicate a factor of safety for the critical slope of at
least 1.5 under dynamic conditions. Regardless of the analysis method used, the stability analysis report shall include at least the following elements:

1. report preparation shall be in accordance with CDMG Note Number 42, "Guidelines for Geologic/Seismic Reports," May 1986, and CDMG Note Number 44, "Guidelines for Preparing Engineering Geologic Reports," April 1986, [both available from the California Division of Mines and Geology (CDMG), 801 K Street, MS14-34, Sacramento, CA 95814-3532, phone 916-445-5716] which are both incorporated by reference, and shall include the following seismicity elements:
   a. a review of earthquakes during historic times;
   b. location of active major faults; and
   c. surface investigation of the site and surrounding area;

2. the location of the critical slope and other slopes analyzed to determine the critical slope shall be shown in map view;

3. calculations used to determine the critical slope;

4. a profile of the critical slope geometry showing the various layers including the proposed fill surface, final cover, mitigation berms, lifts or cells of waste, fluid levels, or any feature that may serve to reduce the stability of the slope or may represent a potential failure surface; and the proposed ground surface, soil or rock layers and structural features;

5. the engineering properties of the refuse and other layers making up the site, shall be analyzed when determining the critical slope. These properties shall include a site specific assessment of the strength parameters, the unit weight and, if using .(9)(5)(D), the shear wave velocity of each of these layers;

6. an assessment of the engineering properties of the underlying foundation materials under both static and dynamic conditions based on field and laboratory tests as determined necessary by a registered civil engineer or certified engineering geologist;

7. the maximum expected horizontal acceleration in rock at the site determined for the design earthquake for the Unit under §20370 [i.e., for Class II Units, the maximum credible earthquake (MCE), and for Class III Units, at least the maximum probable earthquake (MPE)], as supported by data and analysis. For Class III landfills, the maximum expected acceleration in rock from the MCE can be used instead of the MPE;

8. seismic shaking parameters other than acceleration shall also be included in any assessment of dynamic slope stability. These parameters shall include at least earthquake magnitude and duration;

9. documentation of any peer reviewed reduction factor for acceleration applied to attenuate the acceleration through the soil column or fill materials; and

10. documentation, as part of the dynamic stability determination, of any peer reviewed amplification factor used for acceleration in loose saturated soils, if the Unit is located in an area subject to liquefaction, poor foundation conditions, or seismic amplification.

(D) In lieu of achieving a factor of safety of 1.5 under dynamic conditions, pursuant to .(f)(5)(C), the discharger can utilize a more rigorous analytical method that provides a quantified estimate of the magnitude of movement. In this case, the report shall demonstrate that this amount of movement can be accommodated without jeopardizing the integrity of the Unit's foundation or the structures which control leachate, surface drainage, erosion, or gas.

(6) [Reserved.]

(7) Fault Identification & Proximity — Dischargers who own or operate new Class II Units [including expansions of new or existing Units] built after November 27, 1984] shall identify any known Holocene fault within 200 feet of the facility (including any portions of such a fault underlying the Unit) in accordance with a procedure approved by the RWQCB. Dischargers who own or operate new Class III landfills [including expansions of new or existing landfills] shall identify any known Holocene fault underlying the landfill according to a
procedure approved by the RWQCB. After July 18, 1997, dischargers required to submit a slope stability report, under .(f)(5), shall provide a review of historical seismicity within a 100 km (62 mile) radius of the facility, including the name of the fault, type of faulting, activity on the fault, design event for the fault (for Class II Units, the fault's MCE, for Class III Units, the fault's MPE), distance from the facility, the expected ground motions (horizontal and vertical) at the facility resulting from the fault's design event, the expected duration of strong motion at the site resulting from the fault's design event, and an estimation of the cumulative duration of strong motion from aftershocks.

(g) Hydrogeology.

(1) General — An evaluation of the water bearing characteristics of the natural geologic materials identified under .(f)(2) including determination of hydraulic conductivity, delineation of all ground water zones and basic data used to determine the above.

(2) Hydraulic Conductivity — An evaluation of the in-place hydraulic conductivity of soils immediately underlying the Unit. This evaluation shall include:

- (A) hydraulic conductivity data, in tabular form, for selected locations within the perimeter of the Unit;
- (B) a map of the unit showing test locations where these hydraulic conductivity data were obtained; and
- (C) an evaluation of the test procedures and rationale used to obtain these hydraulic conductivity data.

(3) Flow Direction(s) — An evaluation of the perennial direction(s) of ground water movement within the uppermost ground water zone(s) within one mile of the waste management facility's perimeter.

(4) Capillary Rise — Estimates of the height to which water rises due to capillary forces above the uppermost ground water zone(s) beneath and within one mile of the waste management facility perimeter. These estimates shall include an evaluation of the methods and rationale used in their development.

(5) Springs — A map showing the location of all springs within the waste management facility and within one mile of its perimeter. The map shall be accompanied by tabular data indicating the flow and the mineral quality of the water from each spring.

(6) Water Quality — An evaluation, supported by water quality analyses, of the quality of water known to exist under or within one mile of the waste management facility's perimeter, including all data necessary to establish the water quality protection standard (Water Standard) for the Unit, under §20390.

(7) Background — A tabulation of background water quality for all applicable Monitoring Parameters and indicator parameters identified for each applicable monitoring program under §§20420-20435 and for all Constituent of Concern (COCs) identified under §20395.

(A) Background water quality for an indicator parameter, Monitoring Parameter or COC in ground water shall be based on data from quarterly sampling of wells upgradient from the Unit for one year. These analyses shall:

1. account for measurement errors in sampling and analysis; and
2. account for seasonal fluctuations in background water quality, if such fluctuations are expected to affect the concentration of the waste constituent.

(B) In case an evaluation monitoring program is initiated prior to fulfilling the requirements of .(g)(7)(A), the discharger shall, where feasible, establish background water quality based on a combination of all background data then available — including (1) all background data so far taken to satisfy .(g)(7)(A), (2) all background data obtained during accelerated sampling efforts under §20425(b), and (3) all appropriate water quality data from before WDRs were issued — in lieu of the one-year monitoring program under .(g)(7)(A).

(C) Background water quality of ground water shall be based on sampling of wells that are not upgradient from the Unit only where:

1. hydrogeologic conditions do not allow the determination of the upgradient direction; or
2. sampling at other wells will provide a representative indication of background water quality.

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(D) In developing the database used to determine a background value for each indicator parameter or waste constituent in ground water, the discharger shall take a minimum of one sample from each well used to determine background. A minimum of four samples shall be taken from the entire system used to determine background water quality, each time the system is sampled. In a case where there is only one background well, the four measurements per quarter shall be obtained by taking four independent samples, pursuant to §20415(e)(12)(B), and conducting separate analyses for each such sample.

(h) Land and Water Use.

(1) Well Map — A map showing the locations of all water wells, oil wells, and geothermal wells within the facility boundary and showing the locations of all such wells within one mile outside of the facility boundary.

(2) Well Owner — Name and address of the owner of each well indicated in . (h)(1).

(3) Well Information — Well information, where available, for each water well indicated in . (h)(1) including, but not limited to:

(A) total depth of well;
(B) diameter of casing at ground surface and at total depth;
(C) type of well construction (cable tool, rotary, etc.);
(D) depth and type of perforations;
(E) name and address of well driller;
(F) year of well construction;
(G) use of well (agricultural, domestic, stock watering, etc.);
(H) depth and type of seals;
(I) lithologic, geophysical, and other types of well logs, if available; and
(J) water levels, pump tests, water quality, and other well data, if available.

(4) Land Use — Current land use within one mile of the perimeter of the Unit, including:

(A) types of land use (e.g., residential, commercial, industrial, agricultural, recreational, etc.);
(B) types of crops;
(C) types of livestock; and
(D) number and location of dwelling units.

(5) G.W. Use — Current and estimated future use of ground water within one mile of the facility perimeter.

(i) Preliminary Closure Plan — For any proposed Unit (including a proposed lateral expansion of a Unit’s RWQCB-Permitted Area) and for any Unit not yet required to undergo final closure, the ROWD shall contain a preliminary closure and post-closure maintenance plan, under §21769, containing a generalized cost estimate for closure costs and for annualized post-closure costs, supported by sufficient detail to validate the plausibility of the estimate. For any Unit (or portion thereof, in the case of a landfill undergoing complete final closure of a portion of the Unit) that is closing (or that is required to close), the ROWD shall be amended to contain a final closure plan, under §21769, containing sufficient detail for the RWQCB to validate that the closed Unit will meet all applicable SWRCB-promulgated closure-related requirements of this title, and containing an updated, itemized closure cost estimate.


21760. SWRCB - Design Report and Operations Plan. (C15: §2596)

(a) Design Report.
(1) Preliminary and As-Built Plans — As part of the report of waste discharge ("ROWD", including any such report integrated into a Joint Technical Document, pursuant to §21585), dischargers who own or operate classified waste management units (Units) shall submit, for each such Unit, detailed preliminary and (later, after completion) as-built plans, specifications, and descriptions for all liners (under §20330) and other containment structures (e.g., final cover, under §21090), leachate collection and removal system components (under §20340), leak detection system components (under §20415(b-d)), precipitation and drainage control facilities (under §20365), and interim covers installed or to be installed or used (under §20705). In addition, the ROWD shall contain a description of, and location data for, ancillary facilities including roads, waste handling areas, buildings, and equipment cleaning facilities, only insofar as the location and operation of these ancillary facilities could have an effect upon water quality.

(2) [Reserved.]

(3) Monitoring System Plans and Rationale — Dischargers shall submit detailed plans and equipment specifications for compliance with the ground water and unsaturated zone monitoring requirements of Article 1, Subchapter 3, Chapter 3, Subdivision 1 of this division (§20380 et seq.). Dischargers shall provide a technical report which includes rationale for the spatial distribution of ground water and unsaturated zone monitoring facilities, e.g., the location and design of Monitoring Points and Background Monitoring Points for each monitored medium under §20415(b-e)], and for the selection of other monitoring equipment. This report shall be accompanied by the following information, which shall be updated throughout the Unit's active life, closure period, and post-closure maintenance period as needed to reflect the as-built system:

(A) Map — a map showing the locations of proposed monitoring facility components; and

(B) Plans & Specifications — drawings and data showing construction details of proposed monitoring facilities. These data shall include:

1. casing and test hole diameter;
2. casing materials (PVC, stainless steel, etc.);
3. depth of each test hole;
4. the means by which the size and position of perforations shall be determined, or verified, in the field;
5. method of joining sections of casing;
6. nature of filter material;
7. depth and composition of seals;
8. method and length of time of development; and

(C) Unsaturated Zone Monitoring — specifications, drawings, and data for location and installation of unsaturated zone monitoring equipment.

(4) Inspection Procedures — Dischargers shall submit proposed construction and inspection procedures for the Unit [including, after July 18, 1997, a CQA Plan under §21710(a)(5)] to the RWQCB for approval.

(b) Operation Plans — Dischargers shall submit operation plans describing those Unit operations which could affect water quality, including but not limited to:

1. a description of proposed treatment, storage, and disposal methods;
2. contingency plans for the failure or breakdown of waste handling facilities or containment systems, including notice of any such failure, or any detection of waste or leachate in monitoring facilities, to the RWQCB, local governments, and water users downgradient of Units; and
3. a description of inspection and maintenance programs which will be undertaken regularly during disposal operations and the post closure maintenance period.

Subchapter 4. Development of Closure/Post-Closure Maintenance Plans

21769. SWRCB - Closure and Post-Closure Maintenance Plan Requirements. [C15: §2597 // T14: §17776, §17778(g), §18260, §18261.3(a)2 & 7), §18262, §18263, §18264]
[Note: see also §21790 et seq.]

(a) Scope, Applicability, & Purpose — The SWRCB-promulgated sections in this subchapter set forth the requirements for the discharger’s development and implementation of the preliminary and final closure and post-closure maintenance plans and for the RWQCB’s review and approval of such plans. The SWRCB-promulgated sections of this Subchapter apply to all dischargers who own or operate a Class II or Class III Unit that is subject to the SWRCB-promulgated requirements of this subdivision. The purpose of such plans is to ensure that:

(1) Performance Standards — the discharger will close the Unit, and will maintain the Unit during the post-closure maintenance period, in a manner that achieves applicable performance standards under §20950(a)(2); and

(2) Funding — the discharger provides funds, through an acceptable financial mechanism, to achieve the goals of .(a)(1).

(b) Preliminary Closure/Post-Closure Maintenance Plan.

(1) Purpose — The preliminary closure and post-closure maintenance plan for a Unit shall provide a reasonable estimate of the maximum expected cost that would be incurred at any time during the Unit’s projected life for a third party both to close the Unit and to carry out the first thirty years of post-closure maintenance, pursuant to all applicable SWRCB-promulgated requirements of this subdivision, including but not limited to the closure and post-closure requirements under Subchapter 5 of Chapter 3 (§20950 et seq.).

(2) Contents — For Units not jointly regulated by the RWQCB and the CIWMB/EA, this information shall be included as an integrated or separable [e.g., separately bound] part of the ROWD under §21710. For Units jointly regulated by both the RWQCB and the CIWMB/EA, this information shall be included as an integral or separable part of the JTD under §21585. At a minimum, the plan shall include:

(A) Cost Analysis — a lump sum estimate of the cost of carrying out all actions necessary to close the Unit, to prepare detailed design specifications, to develop the final closure and post-closure maintenance plan, and to carry out the first thirty years of post-closure maintenance, pursuant to all applicable SWRCB-promulgated requirements of Subchapter 5 of Chapter 3 (§20950 et seq.); and

(B) Map — a topographic map, drawn at appropriate scale and contour interval, and drawn to an appropriate level of detail, showing:

1. the boundaries of the Unit to be closed, including the proposed final limits of waste placement;
2. the boundaries of the facility; and
3. the boundaries of the waste received, if any, as of the date of the plan submittal;
4. the proposed final contours of the Unit and of its surrounding area; and
5. any changes in surface drainage patterns caused by the proposed final contours of the Unit and of its surrounding area, as compared to the preexisting natural drainage patterns.

(c) Final Closure/Post-Closure Maintenance Plan.

(1) Purpose — The purpose of the final closure and post-closure maintenance plan is:

(A) to provide, for review by the RWQCB, an accurate, detailed list and schedule of all actions necessary to close the Unit and to carry out post-closure maintenance in accordance with all applicable SWRCB-promulgated requirements of this subdivision, including but not limited to the closure and post-closure requirements under Subchapter 5 of Chapter 3 (§20950 et seq.);

(B) to provide, for review by the RWQCB, an accurate estimate of the cost of achieving each action listed in the plan; and
(C) upon the plan’s being approved by the RWQCB, to provide an enforceable list and schedule of actions necessary for providing water quality protection at the Unit during the closure and post-closure maintenance periods.

(2) Contents — The final closure and post-closure maintenance plan for the Unit shall include at least the following information. For Units not jointly regulated by the RWQCB and the CIWMB/EA, this information shall be included as an integrated or separable [e.g., separately bound] part of the ROWD under §21710. For Units jointly regulated by both the RWQCB and the CIWMB/EA, this information shall be included as an integral or separable part of the JTD under §21585. Minimum plan contents shall include:

(A) Itemized Cost Analysis — a detailed itemized listing of all actions, and their associated costs, necessary to close the Unit and to carry out the first thirty years of post-closure maintenance, pursuant to all applicable SWRCB-promulgated requirements of Subchapter 5 of Chapter 3 (§20950 et seq.);

(B) Closure Schedule — a proposed schedule for final closure including, where appropriate, for incremental closure (complete closure of successive portions of the landfill);

(C) Final Treatment Procedures — a description of any final treatment procedures which the discharger proposes to use for the wastes in each Unit, including methods for total removal and decontamination, if applicable. If the discharger is proposing alternative treatment or disposal procedures for particular Units (or, as appropriate, for the entire facility), the plan shall include a description of the alternatives;

(D) Map — a topographic map, drawn at appropriate scale and contour interval, and drawn to an appropriate level of detail, showing:
   1. the boundaries of the Unit(s) to be closed and of the facility;
   2. the projected final contours of the Unit and its surrounding area;
   3. any changes in surface drainage patterns, as compared to the preexisting natural drainage patterns; and
   4. the final limits of waste placement;

(E) Changes To Description Under §21750 — a revised and updated submittal of any Unit characteristics of the closed Unit to the extent that they differ from the description provided by the discharger in the existing ROWD (under §21750);

(F) Changes To Description Under §21760 — a description of the following aspects of the closed Unit, to the extent that they differ from the description provided by the discharger under the Design Report and Operations Plan submitted pursuant to §21760:
   1. the design and the location of all features and systems which will provide waste containment during the post closure maintenance period;
   2. the precipitation, drainage, and erosion control features;
   3. the leachate control features and procedures at closed Units, including the design and operation of the LCRS;
   4. a discussion, including a map, of ground water and unsaturated zone monitoring programs for the closure and post-closure maintenance periods, addressing the location, construction details, and rationale of all monitoring facilities;

(G) MSW — for MSW landfills only, all additional federal requirements incorporated by reference in SWRCB Resolution No. 93-62 for the protection of water quality [see §§258.60(e), and §§258.61(e)(3) and (e) of 40CFR258]; and

(H) Land Use of Closed Unit — the proposed post-closure land use of the disposal site and the surrounding area. If the Unit is to be used for purposes other than nonirrigated open space during the post closure maintenance period, the discharger shall submit a map showing all proposed structures, landscaping, and related features to be installed and maintained over the final landfill cover. This map shall be at a scale of 1” = 100’, unless the RWQCB allows use of another scale that is more appropriate to a given Unit, and shall be accompanied by:

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1. **Water Balance Analysis** — a description and quantification of water entering, leaving, and remaining on site from all sources to determine potential adverse impacts due to the proposed use, and corresponding mitigative design features and monitoring schemes that will ensure the physical and hydraulic integrity of the final cover in spite of the proposed post-closure land use;

2. **Water Penetration Detection Method** — detailed design plans and description(s) of the monitoring schemes, including any associated monitoring system(s), that will effectively detect penetration of the final cover by precipitation or applied irrigation waters; and

3. **Final Cover Protection** — for Units to be closed after July 18, 1997, a description of how the features described in .(c)(2)(H) will be installed, operated, and maintained in a manner that does not jeopardize the performance of the final cover [see §20950(a)(2)(A)].

(d) **Plan Review and Approval** — The RWQCB shall review and approve all preliminary and final closure and post-closure maintenance plans for all portions of the plans which are related to the protection of the waters of the state, including the associated CQA plan, for Class II Units and Class III landfills. For landfill Units jointly regulated by the RWQCB and the CIWMB/EA, the RWQCB’s review and approval of preliminary and final closure and post-closure maintenance plans shall follow the same schedule as for the development or revision of WDRs (see PRC §43506). For landfills, the RWQCB shall review final closure and post-closure maintenance plans in coordination with the EA, pursuant to §21585(b & c).


.21770. **CIWMB - Scope and Applicability.** (T14:§18250)

The CIWMB-promulgated sections in this Subchapter set forth requirements that are additional to the water quality protection requirements set forth in SWRCB-promulgated §§20950, 21090, and 21769. Pursuant to §20005, closure plan review should be coordinated as appropriate with other reviewing agencies.

(a) The CIWMB-promulgated sections of this Subchapter set forth the requirements for the development and approval of closure and postclosure maintenance plans and their implementation. The development of such plans is to ensure that a solid waste landfill will be closed in such a manner as to protect the public health, safety and the environment and to ensure that adequate resources will be available to properly accomplish closure and to maintain the landfill during postclosure maintenance period.

(b) The regulations contained in this Subchapter apply to all solid waste landfills required to be permitted pursuant to PRC §44001 et seq. that were operating on or after January 1, 1988.

(c) The plans required by the CIWMB promulgated sections within this Subchapter shall include other pertinent facilities other than surface impoundments, waste piles, and LTUs regulated by the RWQCB located at the site of the solid waste landfill which are related to the disposal activities at the solid waste landfill.

(d) **Closure and Postclosure Maintenance Plans** shall be written plans to describe the closure of the entire landfill and maintenance requirements after closure in accordance with the requirements of the closure/postclosure standards of Article 2, Subchapter 5, Chapter 3 (§21100 et seq.). The plan shall:

1. Identify the steps necessary to close a solid waste landfill at the point in its active life when the extent and manner of operation would make closure the most expensive;

2. Propose a closure that minimizes the extent of postclosure maintenance necessary while ensuring protection of public health and safety and the environment; and

3. Provide a third party with specific tasks and cost estimates for the closure and postclosure of a solid waste landfill in the event that a third party must assume the responsibility for closure and/or postclosure maintenance.

21780. CIWMB - Submittal of Closure and Postclosure Maintenance Plans.
(T14§18267, §18268, and §18255)
(a) Each submittal shall be certified by a registered civil engineer or a certified engineering geologist. Each submittal shall include:

1. The preliminary or final closure and postclosure maintenance plans containing all of the elements specified under §21790 through §21840, as applicable.

2. Updated cost estimates for closure and postclosure activities to reflect the components under §21820 and §21840.

3. An updated demonstration of financial responsibility in accordance with Subchapter 2 of Chapter 6 (§22205 et seq). This demonstration shall reflect the updated cost estimates for closure and postclosure activities required under (a)(2).

(b) The operator shall submit two copies of each document to the EA, the RWQCB, and the local air district. All drawings shall be submitted at an appropriate scale that clearly shows all pertinent features. The closure and postclosure maintenance plans shall be clearly marked “preliminary” or “final,” depending on the status. For partial final closure, those sections submitted pursuant to §21800, shall be clearly marked “partial final.”

(c) Plans for complete site closure of a solid waste landfill shall be submitted in accordance with the following schedule:

1. Preliminary closure and postclosure maintenance plans for existing solid waste landfills shall be submitted as part of the JTD or as a separate document at the time of application for each SWFP review or revision;

2. preliminary closure and postclosure maintenance plans for new landfills not operating prior to the effective date of the regulations shall be submitted as part of the JTD at the time of application for a SWFP. For the purposes of this Subchapter, lateral expansions of landfills are considered new municipal solid waste landfills;

3. final closure and postclosure maintenance plans for solid waste landfills shall be submitted two years prior to the anticipated date of closure. Within five years of the anticipated date of closure, the operator may submit the final closure and postclosure maintenance plans in lieu of submitting new or updated preliminary closure and postclosure maintenance plans.

(d) Partial final closure of a solid waste landfill shall be allowed in accordance with the following:

1. for the complete closure of discrete units, partial final closure and postclosure maintenance plans shall be submitted for each unit 2 years prior to the anticipated date of closure of that discrete unit in accordance with §§21800 and 21830. Closure of such a discrete unit shall not commence until approval of the partial final closure and postclosure maintenance plans for that discrete unit. The specific closure details for each discrete unit shall be compatible with closure of the entire landfill; and

2. for the implementation of any one or a combination of individual final closure activities, partial final closure and postclosure maintenance plans for the activities shall be approved before implementation of such closure activities.

(e) If immediate closure of a disposal site is necessary to protect public health and safety and the environment, closure plans shall be submitted in accordance with a schedule specified by the EA. An emergency corrective action plan may be required by the EA, to be submitted for approval by the EA. The emergency corrective action plan may be implemented prior to the submittal of the closure plan.

(f) The owner or operator of a MSWLF unit shall notify the EA that closure and postclosure maintenance plans have been prepared and placed in the operating record in accordance with 40 CFR 258.60(d) and 258.61(d).

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 86796.22(d), Government Code. Reference: Sections 66796.22(b) and 66796.22(d), Government Code; and Sections 43020, 43021, 43022 and 43103, Public Resources Code.
21790. CIWMB - Preliminary Closure Plan Contents. (T14:§18261,18261.3)

(a) The purpose of the preliminary plan is to provide a basis for the operator to establish a preliminary estimate of closure costs certified for accuracy by a registered civil engineer or certified engineering geologist, and enable the CIWMB to assess the reasonableness of the cost estimate for non-water quality aspects of closure.

(b) The plan shall identify the steps necessary to perform either partial or full closure, in accordance with §21120, or complete landfill closure and shall include, but is not limited to, the following information:

(1) a closure cost estimate pursuant to §21820;

(2) location maps indicating property boundaries and the existing, permitted, and proposed final limits of waste placement; entry roads; and structures outside the property boundary but within 1000 feet of the property boundary. A location map shall also be included showing the general location of the landfill;

(3) [Reserved];

(4) a location map of the current monitoring and control systems including: leachate control and drainage and erosion control systems as required pursuant to chapter 3 (§20180 et seq.); landfill gas monitoring and control systems as required pursuant to chapter 3 (§20180 et seq.);

(5) a description of proposed postclosure land uses;

(6) an estimate of the maximum extent of the landfill that will ever require closure at any given time during the life of the landfill;

(7) an estimate of the closure date based on volumetric calculations, including supporting documentation. The estimate shall account for the effects of settlement and for volume occupied by daily cover material; and

(8) a preliminary description of closure activities including schedules for implementation. The activities described shall include, but are not limited to:

(A) site security and structure removal pursuant to §§21135 and 21137;

(B) final cover and grading pursuant to §§21140 and 21142. The description shall include type of materials and estimate of the volume or amount needed of each type of material. If on site materials are planned for use in the final cover for the low permeability layer, test results confirming the suitability of such materials shall be included;

(C) construction quality assurance methods pursuant to §§20323 & 20324;

(D) drainage and erosion control systems pursuant to §21150;

(E) landfill gas monitoring and control systems pursuant to Article 6, Subchapter 4, Chapter 3 (§20920 et seq.);

(F) leachate monitoring and control measures pursuant to §21160.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(b) and 88796.22(d), Government Code; and Sections 43020, 43021 and 43103, Public Resources Code.

21800. CIWMB - Final Closure Plan Contents. (T14:§18262,18262.3)

(a) The purpose of the final closure plan is to provide a basis for the operator to establish an accurate detailed estimate of closure costs certified for accuracy by a registered civil engineer or certified engineering geologist, enable the CIWMB to assess the reasonableness of the cost estimate for non-water quality aspects of closure, provide a detailed plan and schedule for the operator to implement upon closure of the landfill, and allow monitoring of closure activities to determine that all requirements of landfill closure have been implemented in accordance with the appropriate plan.
(b) Final closure plans for partial final closure (i.e. the complete closure of discrete units) shall conform to the requirements of this section. Final closure plans for partial closure (i.e. implementation of any one or a combination of individual final closure activities) shall conform to the requirements of this section as applicable.

(c) The final closure plan shall include, but is not limited to, a detailed description of each item contained in §21790(b)(1) through (b)(8). In addition, the final closure plan shall include a detailed description of the sequence of closure stages, giving tentative implementation dates.

(d) The final closure plan shall also include a detailed schedule for disbursement of funds for closure activities from a trust fund, or enterprise fund if applicable, for either:

1. advance payment for activities to be performed in accordance with the plan, or
2. reimbursement of costs paid for activities performed in accordance with the plan.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 66796.22(b) and 66796.22(d), Government Code; and Sections 43020, 43021 and 43103, Public Resources Code.

21810. CIWMB - Final Closure Plan Contents for Clean Closure. (new)  
[Note: see also the SWRCB's clean closure requirements under §21090(d)]

(a) The operator of a solid waste landfill may submit a closure plan for solid waste landfills that will be closed by removing solid wastes and contaminated soils (clean closure).

(b) The purpose of the plan for clean closure is to:

1. establish a closure method for a disposal site that will partially or completely remove solid wastes and contaminated soils to provide remediation of a threat to public health and safety, reduce or eliminate the need for postclosure maintenance, prepare the site for postclosure land uses, or recover materials for recycling or reuse;
2. provide a basis for the operator to establish an accurate detailed cost estimate for clean closure of the site; and
3. provide a plan and schedule for the operator to implement at the time of closure.

(c) Each submittal shall be certified by a registered civil engineer or a certified engineering geologist. The minimum components of a plan for clean closure shall include, but not be limited to:

1. a detailed implementation schedule for clean closure activities;
2. a characterization of the site conditions to define the extent and character of wastes present and the levels and extent of any soil contamination;
3. a description of the excavation and material management procedures to be followed;
4. a description of health and safety procedures to be followed and specific measures to protect public health and safety during clean closure activities; and
5. [Reserved].

(d) The plan for clean closure shall also include a detailed schedule for disbursement of funds for closure activities in accordance with §21800(d).

(e) After clean closure activities are completed, a verification report confirming that waste and residual contaminated soils have been removed shall be prepared by a registered civil engineer or a certified engineering geologist and submitted for approval to the EA and the CIWMB. The report shall include the following information as appropriate:

1. if the plan for clean closure was part of a remedial action, a description of any postclosure maintenance activities needed to comply with the implementation of the remedial action plan. In such cases the unit will not be deemed clean closed until completion of the corrective action.
(2) If all solid waste and contaminated soils are not removed, closure and postclosure maintenance plans and a financial assurance mechanism for closure and postclosure maintenance. Such a unit shall not be regarded as having been clean closed (see §21090(f)).

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 66796.22(b) and 66796.22(d), Government Code; and Sections 43028, 43021 and 43103, Public Resources Code.

.21820. CIWMB - Closure Cost Estimates. (T14:§18263)

(a) The operator shall provide a written cost estimate, in current dollars, of the cost of hiring a third party to close the landfill in accordance with the submitted closure plan. Cost estimates shall meet the following criteria:

(1) Cost estimates shall equal the cost of closing the landfill at the point in its active life when the extent and manner of operation would make closure the most expensive, as indicated by the closure plan;

(2) Cost estimates shall be developed for the activities anticipated for scheduled closure. The closure cost estimate shall always be high enough to ensure that, if, at any time, the landfill had to begin to close, the cost of activities for closure would not exceed the cost estimate;

(3) Cost estimates shall include or reflect the design, materials, equipment, labor, administration and quality assurance necessary for closure;

(4) The total closure cost estimate shall be increased by a factor of 20% to account for cost over runs due to unforeseen circumstances, such as adverse weather conditions and inadequate site characterization, which would result in increased closure costs. The operator may apply to the CIWMB for, and the CIWMB may approve, a contingency percentage of less than 20% at the time that the final closure plan is approved, provided that the CIWMB finds that a lesser percentage will provide acceptable coverage of potential cost overruns;

(5) The operator shall increase the closure cost estimate when changes to the plan or at the landfill increase the cost of closure; and

(6) The operator may reduce the closure cost estimate when changes to the plan or at the landfill decrease the costs of closure. The request for reduction shall be submitted to the CIWMB for approval.

(b) Closure cost estimates shall include, but are not limited to, the following information:

(1) If the documents are preliminary closure and postclosure maintenance plans, an estimate of the cost of developing final closure and postclosure maintenance plans; and

(2) an estimate of the cost of closure activities including schedules for implementation activities. The activities described shall include, but are not limited to:

(A) an estimate of the cost to install or upgrade site security;

(B) an estimate of the cost for structure removal; and

(C) an estimate of the costs to install or upgrade the landfill gas monitoring and control systems.

(c) If the document is a preliminary plan, the items required under (b)(2)(A), (B), and (C) may be provided as lump sum estimates.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(b) and 66796.22(d), Government Code; and Sections 43028, 43021 and 43103, Public Resources Code.

.21825. CIWMB - Preliminary Postclosure Maintenance Plan Contents. (T14:§18264, 18264.3)

(a) The purpose of the preliminary postclosure maintenance plan is to provide a basis for the operator to establish a preliminary estimate of postclosure monitoring, maintenance, and inspection costs certified for accuracy by a
registered civil engineer or certified engineering geologist, and enable the CIWMB to assess the reasonableness of the cost estimate.

(b) The preliminary postclosure maintenance plan shall include, but is not limited to the following information:

(1) a description of the planned uses of the property during the postclosure maintenance period in accordance with §21190; and

(2) a preliminary description of the methods, procedures, and processes that will be used to maintain, monitor and inspect the closed landfill during the postclosure maintenance period to comply with §21180.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 66796.22(b) and 66796.22(d), Government Code; and Sections 43020, 43021 and 43103, Public Resources Code.

.21830. CIWMB - Final Postclosure Maintenance Plan Contents. (T14:§18265,18265.3)

(a) The purpose of the final postclosure maintenance plan is to provide a basis for the operator to establish an accurate detailed cost estimate certified for accuracy by a registered civil engineer or certified engineering geologist, enable the CIWMB to assess the reasonableness of the cost estimate, and provide a detailed plan for the inspection, maintenance, and monitoring of the landfill during the postclosure maintenance period.

(b) The final postclosure maintenance plan shall include, but is not limited to, the following information:

(1) the emergency response plan as required by §21130 of Chapter 3, Subchapter 5;

(2) the persons or companies responsible for each aspect of postclosure maintenance, and their addresses and telephone numbers;

(3) a description of the planned uses of the property during the postclosure maintenance period in accordance with §21190 of Chapter 3, Subchapter 5;

(4) an as built description of the current monitoring and control systems at the landfill including a detailed description of any proposed changes to be implemented as part of closure. This description shall be kept current throughout the postclosure maintenance period;

(5) a detailed description of the methods, procedures and processes that will be used to maintain, monitor and inspect the closed landfill during the postclosure maintenance period to comply with §21180 of Chapter 3, Subchapter 5;

(6) an operations and maintenance plan for the gas control system;

(7) a summary of the requirements for reporting the results of monitoring and collection, pursuant to section 21180 of chapter 3, Subchapter 5; and

(8) the postclosure maintenance cost estimates pursuant to §21840 of this Subchapter.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(b) and 66796.22(d), Government Code; and Sections 43020, 43021 and 43103, Public Resources Code.

.21840. CIWMB - Postclosure Maintenance Cost Estimates. (T14:§18266)

(a) The operator shall provide a written estimate, in current dollars, of the cost of hiring a third party to maintain, monitor, and inspect the closed landfill in accordance with the postclosure maintenance plan requirements. Cost estimates shall be subject to the following requirements:

(1) Cost estimates shall be based on the activities described in the postclosure maintenance plan and account for postclosure maintenance of the entire landfill;

(2) The cost estimate used to demonstrate financial assurance, shall be the annual cost of maintenance and monitoring anticipated during the postclosure period, multiplied by thirty (30) years; and
(3) The operator shall modify the postclosure cost estimate, in accordance with §21865 of this Subchapter, when changes in the plan or landfill conditions indicate an increase or decrease in postclosure maintenance costs. Requests for modifications shall be submitted to the CIWMB for approval.

(b) Preliminary postclosure maintenance plans shall include a lump sum estimate of the annual cost of postclosure monitoring and maintenance in accordance with (c).

(c) Final postclosure maintenance plans shall include a detailed estimate of the annual costs for postclosure monitoring and maintenance, including the following:

(1) site security pursuant to §21135;

(2) maintenance and integrity of the final cover including material acquisition, labor, and placement for repair of the final cover as required due to the effects of settlement, slope failure, or erosion;

(3) maintenance of vegetation including fertilization, irrigation and irrigation system maintenance;

(4) monitoring, operation and maintenance of the landfill gas monitoring and control systems;

(5) maintenance of the drainage and erosion control systems including clearing materials blocking drainage conveyances and repairing drains, levees, dikes and protective berms.


21860. CIWMB - Schedules for Review and Approval of Closure and Postclosure Maintenance Plans. (T14-§18271)

(a) The schedule for review and approval must conform to provisions of this section. An alternative schedule may be proposed by the operator provided it complies with applicable statute and the EA and RWQCB concur.

(b) Within 30 days of receipt of closure and postclosure maintenance plans shall be deemed complete by default unless the RWQCB, the EA (or the CIWMB, pursuant to 14CCR §18072), determines and informs the operator that the plan is incomplete pursuant to applicable CIWMB and SWRCB requirements. If determined to be incomplete, the EA and the RWQCB shall provide to each other and to the operator a list of specific items missing from the submittal.

(c) If the closure and postclosure maintenance plan is determined by the RWQCB, the EA (or the CIWMB pursuant to Title 14, §18072), to be incomplete, the operator shall resubmit a revised closure and postclosure maintenance plan incorporating all items deemed to be missing from the prior submittal within 60 days following such determination, unless the EA and the RWQCB approve an alternate schedule.

(d) Within 120 days of submittal, a complete closure and postclosure maintenance plan shall be deemed approved unless the RWQCB, the EA and, as appropriate pursuant to 14CCR §18072, the CIWMB, determines and informs the operator that the plan cannot be approved because of lack of compliance with applicable CIWMB and SWRCB requirements. The RWQCB, the EA and, as appropriate pursuant to Title 14, §18072, the CIWMB, shall coordinate their review of the closure and postclosure maintenance plans, including any revisions thereto, to the extent feasible during the 120 day period. These agencies shall also coordinate with the operator to allow for revisions, if feasible, of the closure and postclosure maintenance plan, to the extent that these revisions ensure that the plan can be approved.

(e) If the closure and postclosure maintenance plan is determined by the EA and, as appropriate pursuant to Title 14, §18072, the CIWMB, to be unapprovable, or is disapproved by the RWQCB, the operator shall resubmit a revised closure and postclosure maintenance plan that ensures compliance with applicable requirements, within 60 days following such determination or disapproval, unless the EA and the RWQCB approve an alternate schedule.

(f) Within 30 days after the end of the 120-day review and approval period, the EA and the RWQCB shall inform the CIWMB by letter of whether they have approved or denied the closure and postclosure maintenance
plan. The RWQCB shall provide copies of any WDR adopted or revised as a result of the review and approval process. In addition, the EA shall provide the CIWMB with two copies of the approvable closure and postclosure maintenance plans.

(g) Within 30 days of receipt of the approval letters from the EA and the RWQCB, and copies of the approvable closure and postclosure maintenance plans, the CIWMB shall determine if an approval letter for the plans can be issued by the CIWMB. The CIWMB shall not approve the plans if:

1. the EA has determined the closure and postclosure maintenance plan or its revised version cannot be approved or the RWQCB has disapproved the plan; or

2. the CIWMB determines that the closure and postclosure maintenance plan is inadequate due to substantive deficiencies in the plan or in the financial assurance mechanism, or that the mechanism is not adequately funded for that point in the landfill’s life.

(h) If the CIWMB does not approve a closure and postclosure maintenance plan, it shall provide to the operator an explanation of its action and reasons for disapproval, and shall provide notice to the EA and the RWQCB.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 66786.22(b) and 66796.22(d), Government Code; and Sections 21080.5 and 43103, Public Resources Code.

.21865. CIWMB - Amendment of Closure and Postclosure Maintenance Plans.
(T14 §18272)

(a) Preliminary closure and postclosure maintenance plans shall be submitted as part of the JTD or a separate document every time a review or revision of the SWFP is conducted. If the preliminary closure and postclosure maintenance plans have been previously approved and a new horizontal or vertical expansion of a solid waste landfill is not proposed, the form of submittal shall be as amendments to the existing plans as necessary. Submittal shall be in accordance with §21780. The evaluation and approval of the plan amendments shall be as specified under §21860.

(b) The plans shall be amended to reflect the following:

1. A change in operation or solid waste landfill design which would affect the implementation of the closure and/or postclosure maintenance plans;

2. A change in the anticipated year of closure;

3. Any change in the financial mechanism required pursuant to §22227, “Substitution of Mechanisms” or §22231, “Cancellation or Nonrenewal by a Provider of Financial Assurance”; or

4. Updates of the cost estimates as required by Chapter 6 to reflect any changes outlined under .(b)(1) and .(b)(2). These updates shall be adjusted for inflation which has occurred since the previous approval.

NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Section 43103, Public Resources Code.

.21870. CIWMB - Implementation of Closure Plan. (new)

(a) Closure Plan implementation shall adhere to the schedules specified in §21800 and 21810.

(b) Closure, partial final closure, and partial closure activities shall not commence until there is an approved closure and postclosure maintenance plan for the solid waste landfill.

(c) Closure, partial final closure, and partial closure activities shall be conducted pursuant to the approved closure and postclosure maintenance plan.
(d) The EA shall be responsible for ongoing inspections of closure activities and for approval of minor changes from the specifications contained in the approved closure plan. The CIWMB shall inspect closure activities as necessary to authorize release of financial assurances and shall upon concurrence with the EA approve significant changes from the specifications contained in the approved closure plan.

(e) On the day that implementation of the closure plan begins for the complete closure of a solid waste landfill, the SWFF shall be null and void, and the provisions of the closure and postclosure maintenance plans shall be enforceable.
NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Section 43103, Public Resources Code.

.21880. CIWMB - Certification of Closure. (T14:§18275)
(a) The operator shall submit to the CIWMB, the EA, and the RWQCB for approval a certification, under penalty of perjury, that the solid waste landfill has been closed in accordance with the approved final closure plan.

(b) The certification shall be completed by a registered civil engineer or certified engineering geologist and include a report with supporting documentation. The report shall include a Final Construction Quality Assurance (CQA) report pursuant to Article 2 of Subchapter 1 of Chapter 3 (§20323 and §20324 et seq.) and any other documentation as necessary to support the certification. The certification, Final CQA report and any other documentation as necessary to support the certification shall be incorporated into the approved postclosure maintenance plan.

(c) Once the certification has been approved by the CIWMB and the EA, the CIWMB shall release the operator from the financial mechanism for closure.

(d) On the day that the certification of closure is approved, the closure plan shall be superseded by the postclosure maintenance plan as the enforceable document for the disposal site.
NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Sections 43020, 43021, 43103 and 44006, Public Resources Code.

.21890. CIWMB - Revision of Approved Plans For Closure and Postclosure Maintenance. (T14:§18276)
(a) The operator shall adhere to the final closure and postclosure maintenance plans approved pursuant to §21860. Significant changes to the closure and postclosure maintenance plans, after approval of the final plan, shall upon concurrence with the EA be approved by the CIWMB, and the RWQCB.

(b) Postclosure maintenance plans may be revised during the postclosure maintenance period upon concurrence with the EA and approval by the CIWMB, and the RWQCB.
NOTE: Authority cited: Section 40502, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Sections 66796.22(b)(2) and 66796.22(h), Government Code; and Section 43103, Public Resources Code.

.21900. CIWMB - Release From Postclosure Maintenance. (T14:§18277)
(a) The operator of a solid waste landfill may be released from postclosure, after a minimum period of thirty (30) years upon demonstration to and approval by the CIWMB, the EA, and the RWQCB that the solid waste landfill no longer poses a threat to the public health and safety and the environment.
NOTE: Authority cited: Sections 40502 and 43020, Public Resources Code; and Section 66796.22(d), Government Code. Reference: Section 66796.22(d), Government Code; and Sections 43020, 43021 and 43103, Public Resources Code.
Chapter 5. Enforcement

Articles 1-3. (Reserved - CIWMB)

Article 4. Enforcement by Regional Water Quality Control Board (RWQCB)

.22190. SWRCB - Mandatory Closure (Cease and Desist Orders). (C15: §2593)

(a) Source Control — If the RWQCB finds that early closure of a waste management unit (Unit) is necessary to prevent (or curtail) violation of waste discharge requirements [e.g., as a source control measure in corrective action, under §20430(c)], it shall adopt a Cease and Desist Order, pursuant to §13302 of the Water Code, which requires closure according to a closure and post closure maintenance plan approved by the RWQCB.

(b) New/Updated Plan — Any time a Unit is subjected to early closure, under (a), the discharger shall, in accordance with a schedule of compliance issued by the RWQCB, submit to the RWQCB a report including an appropriate closure and post closure maintenance plan (under §21769), if such a plan applicable to the early-closed configuration of the Unit was not submitted with the report of waste discharge and including a revised schedule for immediate termination of operations and closure.


Chapter 6. Financial Assurances at Solid Waste Facilities and at Waste Management Units for Solid Waste

Subchapter 1. Definitions for Financial Assurance Demonstrations and Requirements

.22200. CIWMB - Definitions. (T14:§18281)

When used in this Chapter, the following terms shall have the meanings given below:

(a) “Accidental occurrence” means an event, including pollution exposures, which occurs during the operation of a disposal facility prior to closure, that results in bodily injury and/or property damage, and includes continuous or repeated exposure to conditions, neither expected nor intended from the standpoint of the facility operator.

(b) “Admitted carrier” means an insurance company entitled to transact the business of insurance in this state, having complied with the laws imposing conditions precedent to transactions of such business.

(c) “Annual capacity filled” means the portion of a solid waste landfill’s total permitted capacity that was filled during the following period:

1) From August 18, 1989 until 60 days prior to the anniversary date of the establishment of a trust fund or an enterprise fund; and

2) From 60 days prior to each anniversary date of the establishment of a trust fund or an enterprise fund that occurs before the subsequent anniversary date.

(d) “Assets” means all existing and all probable future economic benefits obtained or controlled by a particular entity as a result of past transactions.

(e) “Auto” means a land motor vehicle, trailer or semitrailer designed for travel on public roads, including any attached machinery or equipment. But “auto” does not include “mobile equipment,” as defined in .(aa).

(f) “Bodily injury” means any injury to the body, sickness or disease sustained by a person, including death resulting from any of these at any time. Damages because of “bodily injury” include damages claimed by any person or organization for care, loss of services or death resulting at any time from the “bodily injury.”

“Bodily injury” excludes:
(1) “Bodily injury” expected or intended from the standpoint of the operator. This exclusion does not apply to “bodily injury” resulting from the use of reasonable force to protect persons or property.

(2) “Bodily injury” for which the operator is obligated to pay damages by reason of the assumption of liability in a contract or agreement. This exclusion does not apply to liability for damages that the operator would have in the absence of the contract or agreement.

(3) Any obligation of the operator under a workers compensation, disability benefits or unemployment compensation law or any similar law.

(4) “Bodily injury” to:

(A) An employee of the operator arising out of and in the course of employment by the operator; or

(B) The spouse, child, parent, brother or sister of that employee as a consequence of (A) above.

This exclusion applies:

1. Whether the operator may be liable as an employer or in any other capacity; and

2. To any obligation to share damages with or repay someone else who must pay damages because or the injury.

(5) “Bodily injury” arising out of the ownership, maintenance, use or entrustment to others of any aircraft, “auto” or watercraft owned or operated by or rented or loaned to any operator. Use includes operation and loading or unloading. This exclusion does not apply to:

(A) Parking an “auto” on, or on the ways next to, premises the operator owns or rents, provided the “auto” is not owned by or rented or loaned to the operator;

(B) “Bodily injury” arising out of the operation of any of the equipment listed in (6)(A) or (6)(B) of the definition of “mobile equipment”, found in (aa) below.

(g) “Cash plus marketable securities” means all the cash plus marketable securities held by the local government on the last day of the fiscal year, excluding cash and marketable securities designated to satisfy past obligations such as pensions. Cash plus marketable securities form the numerator of the liquidity ratio.

(1) Cash and cash equivalents means bank deposits, very short-term debt securities, and money market funds.

(2) Marketable securities means interest or dividend bearing securities in the General Fund, Special Revenue Funds, Debt Service Fund, Enterprise Funds and Internal Service Funds, as reported on the comprehensive annual financial report’s (CAFR’s) Combined Balance Sheet and that are expected to be held for less than one year.

(3) Excluded from this definition are accounts receivable, retirement assets, real property, fixed assets, and other non-current assets, as well as any assets (including cash) in Capital Projects Funds.


(i) “Cumulative capacity filled” means the sum of the annual capacities filled since August 18, 1989.

(j) “Current assets” means cash or other assets or resources commonly identified as those that are reasonably expected to be realized in cash or sold or consumed during the normal operating cycle of the business.

(k) “Current closure cost estimate” means the most recent of the estimates prepared in accordance with §21820.

(l) “Current liabilities” means obligations whose liquidation is reasonably expected to require the use of existing resources properly classifiable as current assets or the creation of other current liabilities.

(m) “Current postclosure cost estimate” means the most recent of the estimates prepared in accordance with §21840.
(n) "Debt service" means the amount of principal and interest due on a loan in the latest completed fiscal year. Annual debt service is the numerator of the debt service ratio. The debt service ratio provides an indicator of ability to meet financial obligations in a timely manner.

(1) Sum of amounts in any debt service category including bond principal, other debt principal, interest on bonds, interest on other debt in the General Fund, Special Revenue Funds, Debt Service Fund, and Capital Projects Funds.

(2) Debt service amounts are reported in the comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenditures and Changes in Fund Balances/Equity.

(3) Interest expense in Enterprise Funds and Internal Service Funds are reported in comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenses and Changes in Retained Earnings/Fund Balances.

(o) "Enterprise fund" means a fund meeting the requirements of §22241, of Article 2, of Subchapter 3, of this Chapter, that is established to account for the financing of self-supporting activities of a government unit that renders services on a user-fee basis.

(p) "Excess coverage" means assurance for third party bodily injury and property damage costs that are above a specified level (i.e., above the primary coverage level or a limit of lower excess coverage) but up to a specified limit.

(q) "Federal entity" means the United States Government, or any department, agency, or instrumentality thereof.

(r) "Financial means test" means the financial assurance mechanism specified in §22246 of Article 2 of Subchapter 3 of this Chapter by which an operator demonstrates his or her ability to pay third party claims for bodily injury and property damage caused by accidental occurrences and/or to pay future postclosure maintenance costs by satisfying the prescribed set of financial criteria.

(s) "Financial reporting year" means the twelve-month period for which financial statements that are used to support the financial means test are prepared.

(t) "Fully funded" means the value of a closure and/or postclosure maintenance and/or corrective action fund is equal to, or greater than, the total current closure and/or postclosure maintenance and/or corrective action cost estimate(s) for the facility(ies) covered.

(u) "Government securities" means financial obligations meeting the requirements of §22242 of Article 2 of Subchapter 3 of this Chapter that are issued by a federal, state, or local government, including but not limited to, general obligation bonds, revenue bonds, and certificates of participation.

(v) "Guarantee" means a contract meeting the requirements of §22247, of Article 2 of Subchapter 3 of this Chapter, by which a guarantor promises that, if the operator fails to perform postclosure maintenance, or to adequately compensate legitimate third party claimants for bodily injury and/or property damage caused by an accidental occurrence, the guarantor will perform postclosure maintenance, compensate the third party for damages, or will establish and fund a trust fund in the name of the operator to pay for such activities.

(w) "Guarantor" means a parent corporation, or a corporation with a substantial business relationship to the operator who guarantees payment of a present or future obligation(s) of an operator.

(x) "Insurance" means a contract meeting the requirements of §22248 or §22251 of Article 2 of Subchapter 3 of this Chapter by which an insurer promises to pay for closure, postclosure maintenance or corrective action, or a claim by a third party for bodily injury and property damage caused by an accidental occurrence.

(y) "Legal defense costs" means expenses that an operator or a provider of financial assurance incurs in defending claims brought:

(1) By or on behalf of a third party for bodily injury and/or property damage caused by an accidental occurrence; or

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(2) By any person to enforce the terms of a financial assurance mechanism.

(2) "Letter of credit" means a contract meeting the requirements of §22243, of Article 2 of Subchapter 3 of this Chapter, by which the issuing institution promises to extend credit on behalf of an operator to the CIWMB upon the presentation of the mechanism in accordance with its terms.

(a) "Liabilities" means probable future sacrifices of economic benefits arising from present obligations to transfer assets or provide services to other entities in the future, as a result of past transactions or events.

(bb) "Minimum fund balance" means the required minimum balance maintained in a trust fund or enterprise fund in compliance with the formula(s) in §22225 or §22226 of Article 1 of Subchapter 3 of this Chapter.

(ce) "Mobile equipment" means any of the following types of land vehicles, including any attached machinery or equipment:

(1) Bulldozers, farm machinery, forklifts and other vehicles designed for use principally off public roads;

(2) Vehicles maintained for use solely on or next to premises the operator owns or rents;

(3) Vehicles that travel on crawler treads;

(4) Vehicles, whether self-propelled or not, maintained primarily to provide mobility to permanently mounted:
   (A) Power cranes, shovels, loaders, diggers or drills; or
   (B) Road construction or resurfacing equipment such as graders, scrapers or rollers;

(5) Vehicles not described in . . . (1), (2), (3) or (4) above that are not self-propelled and are maintained primarily to provide mobility to permanently attached equipment of the following types:
   (A) Air compressors, pumps and generators, including spraying, welding, building cleaning, geophysical exploration, lighting and well servicing equipment; or
   (B) Cherry pickers and similar devices used to raise or lower workers;

(6) Vehicles not described in . . . (1), (2), (3) or (4) above maintained primarily for purposes other than the transportation of persons or cargo. However, self-propelled vehicles with the following types of permanently attached equipment are not "mobile equipment" but will be considered "autos":
   (A) Equipment designed primarily for:
      1. Snow removal;
      2. Road maintenance, but not construction or resurfacing;
      3. Street cleaning;
   (B) Cherry pickers and similar devices mounted on automobile or truck chassis and used to raise or lower workers; and
   (C) Air compressors, pumps and generators, including spraying, welding, building cleaning, geophysical exploration, lighting and well servicing equipment.

(dd) "Net working capital" means current assets minus current liabilities.

(ee) "Net worth" means total assets minus total liabilities and is equivalent to owner's equity.

(ff) "Operating deficit" means total expenditures minus total revenues.

(gg) "Parent corporation" means a corporation that owns directly or through its subsidiaries at least 50 percent of the voting stock of another corporation.

(hh) [Reserved]
(ii) "Pledge of revenue" means a financial assurance mechanism meeting the requirements of §22245, of Article 2 of Subchapter 3 of this Chapter, by which a government unit promises to make specific, identified future revenue available to pay future postclosure maintenance costs.

(jj) "Primary coverage" means the first priority coverage for third party bodily injury and property damage costs, and closure and/or postclosure maintenance costs, up to a specified limit when used in combination with other coverage.

(kk) "Property damage" means physical injury to tangible property, including all resulting loss of use of that property, or loss of use of tangible property that is not physically injured. "Property damage" excludes:

(1) "Property damage" expected or intended from the standpoint of the operator.

(2) "Property damage" for which the operator is obligated to pay damages by reason of the assumption of liability in a contract or agreement. This exclusion does not apply to liability for damages that the operator would have in the absence of the contract or agreement.

(3) An obligation of the operator under a workers' compensation, disability benefits, or unemployment compensation law or similar law.

(4) "Property damages" arising out of the ownership, maintenance, use or entrustment to others of any aircraft, "auto" or watercraft owned or operated by or rented or loaned to any operator. Use includes operation and loading and unloading. This exclusion does not apply to:

(A) Parking an "auto" on, or on the ways next to, premises the operator owns or rents, provided the "auto" is not owned by or rented or loaned to the operator;

(B) "Property damage" arising out of the operation of any of the equipment listed in .(6)(A) or .(6)(B) of the definition of "mobile equipment," found in (cc) above.

(5) "Property damage" to:

(A) Any property owned, rented, or occupied by the operator;

(B) Premises that are sold, given away, or abandoned by the operator if the "property damage" arises out of any part of those premises;

(C) Property loaned to the operator;

(D) Personal property in the care, custody, or control of the operator; and

(E) That particular part of real property on which the operator or any contractors or subcontractors working directly or indirectly on behalf of the operator are performing operations, if the "property damage" arises out of those operations, or

(F) That particular part of any property that must be restored, repaired or replaced because the operator's work was incorrectly performed on it.

(II) "Provider of financial assurance" means an entity, other than the operator of a disposal facility, that provides financial assurance to the operator including, but not limited to, a trustee, an institution issuing a letter of credit, a surety company, an insurer, a guarantor, or an institution providing a financial assurance mechanism used in conjunction with an enterprise fund, government securities, or pledge of revenue.

(nn) "Remaining cost estimate" means the value remaining when the current value of a closure and/or postclosure maintenance fund is subtracted from the current closure and/or postclosure maintenance cost estimate(s).

(nn) "Remaining permitted capacity" means the total permitted capacity at the disposal facility less the cumulative capacity filled at the disposal facility since August 18, 1989.

(oo) "Substantial business relationship" means a business relationship that arises from a pattern of recent or ongoing business transactions.
(pp) "Surety bond" means a contract meeting the requirements of §22244, of Article 2, of Subchapter 3, of this Chapter, by which a surety company promises that, if the operator fails to perform required closure and/or postclosure maintenance and/or corrective action, the surety company will be liable for the operator's responsibilities as specified by the bond.

(qq) "Tangible net worth" means the tangible assets that remain after deducting liabilities; such assets do not include intangibles such as goodwill and rights to patents or royalties.

(rr) "Total expenditures" means the sum of the six items listed in subsections (1) and (2) below.

(1) Items 1-3 reported on the comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenses and Changes in Fund Balances/Equity:

(A) Total Expenditures of the General Fund.
(B) Total Expenditures of Special Revenue Funds.
(C) Total Expenditures of the Debt Service Fund.

(2) Items 4-6 reported on the comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenses and Changes in Retained Earnings/Fund Balances:

(A) Total Operating Expenses Before Depreciation of Enterprise Funds
(B) If negative, Total Non-Operating Revenues (Net) of Enterprise Funds.
(C) If negative, Total Non-Operating Revenues (Net) of Internal Service Funds.

(3) Total expenditures is used in the liquidity and debt service ratios, and operating deficit limit.

(4) Include routine capital outlays that are accounted for in the General Fund, e.g. outlays for police vehicles, copy equipment; any capital outlays that are funded on a "pay-as-you-go" basis.

(5) Exclude non-routine capital outlays, which are generally accounted for in Capital Projects Funds.

(ss) "Total permitted capacity" means the capacity approved by the disposal facility permit, including any changes in capacity approved by a new permit or a permit modification; but excluding any capacity filled prior to August 18, 1989.

(tt) "Total revenues" means the sum of the seven items listed in subsections (1) and (2) below, and is used in the calculation of costs which can be assured by the local government financial test.

(1) Items 1-4 reported on the comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenses and Changes in Fund Balances/Equity:

(A) Total Revenues of the General Fund.
(B) Total Revenues of Special Revenue Funds.
(C) Total Revenues of the Debt Service Fund.
(D) Total Revenues of Capital Projects Funds.

(2) Items 5-7 reported on the comprehensive annual financial report's (CAFR's) Combined Statement of Revenues, Expenses and Changes in Retained Earnings/Fund Balances:

(A) Total Operating Revenues of Enterprise Funds.
(B) If positive, Total Non-Operating Revenues (Net) of Enterprise Funds.
(C) If positive, Total Non-Operating Revenues (Net) of Internal Service Funds.

(3) Total revenues is used in calculation of operating deficit and the limit on costs.

(uu) "Trust fund" means a contract meeting the requirements of §22240, of Article 2, of Subchapter 3 of this Chapter, by which the operator transfers assets to a trustee to hold on behalf of the CIWMB or its designee to pay
Subchapter 2. Financial Assurance Requirements

Article 1. Financial Assurance for Closure

.22205. CIWMB - Scope and Applicability. (T14:§18280)
(a) This article requires operators of solid waste landfills to demonstrate the availability of financial resources to conduct closure activities.

(b) The requirements of this article apply to operators of all disposal facilities that are required to be permitted as solid waste landfills pursuant to Chapter 4 of this Division and have been or will be operated on or after January 1, 1988.

(c) Operators of all disposal facilities shall comply with the requirements of this Article upon application for issuance, amendment, modification, revision or review of an SWFP, commencing the effective date of this Article.


.22206. CIWMB - Amount of Required Coverage. (T14:§18282)
(a) Except as otherwise noted in §22228 of Article 1 of Subchapter 3 of this Chapter, the operator of each solid waste landfill shall demonstrate financial responsibility to the CIWMB for closure in at least the amount of the current closure cost estimate.


.22207. SWRCB - Closure Funding Requirements. [C15: §§2574(e,g) and 2580(f)]
The requirements of this section apply to dischargers who own or operate a Class II, or Class III waste management unit (Unit) or a mining waste management unit (mining Unit).

(a) Unit Closure Funding - At Class II and Class III Units for which the CIWMB does not require a closure fund, the RWQCB shall require the discharger to establish an irrevocable closure fund (or to provide other means) pursuant to the CIWMB-promulgated sections of this chapter but with the RWQCB named as beneficiary, to ensure closure of each classified Unit in accordance with an approved plan meeting all applicable SWRCB-promulgated requirements of this subdivision. For solid waste disposal sites, the RWQCB shall coordinate with the CIWMB, pursuant to §20950(f).

(b) Mining Unit Closure Funding - For mining Units only, the discharger shall provide for adequate funding to pay for the costs of closure as required by the mining regulations of Article 1, Subchapter 1, Chapter 7 of this division (§22470 et seq.). The discharger shall provide assurance of financial responsibility acceptable to the RWQCB. The RWQCB shall periodically review financial assurances for mining Units and shall modify the financial assurances as necessary to provide continued compliance with this section. If a lead agency acting under the authority of §2774(a) of the Public Resources Code requires assurances of financial responsibility for a mining Unit, these assurances can be used to fulfill the requirement under this paragraph, provided that:

(1) the RWQCB approves the assurance; and
(2) the RWQCB is named as alternate payee.

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Article 2. Financial Assurance for Postclosure Maintenance

22210. CIWMB - Scope and Applicability. (T14:§18280)  
(a) This article requires operators of solid waste landfills to demonstrate the availability of financial resources to conduct postclosure maintenance activities.  
(b) The requirements of this article apply to operators of all disposal facilities that are required to be permitted as solid waste landfills pursuant to Chapter 4 of this Division and have been or will be operated on or after January 1, 1988.  
(c) Operators of all disposal facilities shall comply with the requirements of this Article upon application for issuance, amendment, modification, revision or review of a SWFP, commencing the effective date of this Article.  

22211. CIWMB - Amount of Required Coverage. (T14:§18282)  
(a) Except as otherwise noted in §22225, the operator of each solid waste landfill shall demonstrate financial responsibility to the CIWMB for postclosure maintenance in at least the amount of the current postclosure cost estimate.  

22212. SWRCB - Post-Closure Funding Requirements. [C15: §§2574(f&g) and 2580(f)]  
The requirements of this section apply to dischargers who own or operate a Class II or Class III waste management unit (Unit) or a mining waste management unit (mining Unit).  
(a) Non-Mining Units — At Class II and Class III Units for which the CIWMB does not require a closure fund, the RWQCB shall require the discharger to establish an irrevocable fund (or to provide other means) pursuant to the CIWMB-promulgated sections of this chapter but with the RWQCB named as beneficiary, to ensure post closure maintenance of each classified Unit in accordance with an approved plan meeting all applicable requirements of this subdivision. For solid waste landfills, the RWQCB shall coordinate with the CIWMB, pursuant to §20950(f).  
(b) Mining Units — The discharger shall provide for adequate funding to pay for the costs of closure post closure maintenance at mining Units, as required by the mining regulations of Article 1, Subchapter 1, Chapter 7 of this division (§22470 et seq.). The discharger shall provide assurance of financial responsibility acceptable to the RWQCB. The RWQCB shall periodically review financial assurances for mining Units and shall modify the financial assurances as necessary to provide continued compliance with this section. If a lead agency acting under the authority of §2774(a) of the Public Resources Code requires assurances of financial responsibility for a mining Unit, these assurances can be used to fulfill the requirement under this paragraph, provided that:  

(1) the RWQCB approves the assurance; and  
(2) the RWQCB is named as alternate payee.  
Article 3. CIWMB - Financial Assurance Requirements for Operating Liability

22215. CIWMB - Scope and Applicability. (T14:§18230)
(a) This article requires operators of disposal facilities to demonstrate adequate financial ability to compensate third parties for bodily injury and property damage caused by facility operation prior to closure.
(b) Operators of all disposal facilities, except state and federal operators, shall comply with the requirements of this Article upon application for issuance, amendment, modification, revision or review of a SWFP, commencing July 1, 1992.

22216. CIWMB - Amount of Required Coverage. (T14:§18232)
(a) An operator of one or more disposal facilities shall demonstrate financial responsibility for compensating third parties for bodily injury and property damage caused by any accidental occurrences, including exposures to pollution, in at least the amount of:
   (1) One million dollars ($1,000,000) per occurrence; and
   (2) One million dollars ($1,000,000) annual aggregate for 1 facility.
   (3) Two million dollars ($2,000,000) annual aggregate for 2 facilities.
   (4) Three million dollars ($3,000,000) annual aggregate for 3 facilities.
   (5) Four million dollars ($4,000,000) annual aggregate for 4 facilities.
   (6) Five million dollars ($5,000,000) annual aggregate for 5 or more facilities, which is the maximum coverage required.
(b) The required amounts of coverage shall be exclusive of legal defense costs, deductibles and any self-insured retention.
(c) The required amounts of coverage shall apply exclusively to an operator's facility or facilities located in the State of California.
(d) An operator may use one or more mechanisms to provide proof of financial assurance.
(e) If a trust fund or government securities is depleted to compensate third parties for bodily injuries and/or property damages caused by accidental occurrences, the operator shall, within one year of the depletion, demonstrate financial responsibility for the full amount of coverage required by (a) by replenishing the depleted mechanism(s) and/or acquiring additional financial assurance mechanism(s).
(f) If an environmental liability fund is depleted to compensate third parties for bodily injuries and/or property damages caused by an accidental occurrence, the operator shall, within one year of the depletion, demonstrate financial responsibility for the full amount of coverage required by §22253, as if no depletion had occurred.

Article 4. Financial Assurance Requirements for Corrective Action

22220. CIWMB - Scope and Applicability. (new)
(a) This article requires operators of disposal facilities to demonstrate the availability of financial resources to conduct corrective action activities as required under Article 1, Subchapter 3, Chapter 3 (§20380 et seq.).
(b) The requirements of this article apply to operators of all disposal facilities that are required to be permitted as solid waste landfills and have been or will be operated on or after July 1, 1991.
22221. CIWMB - Amount of Required Coverage. (T14:§17258.73)

(a) Except as otherwise noted in §22226, the operator of each disposal facility shall demonstrate financial responsibility to the CIWMB for initiating and completing corrective action for all known or reasonably foreseeable releases from the disposal facility as required under Article 1, Subchapter 3, Chapter 3 (§20380 et seq.) in at least the amount of the current corrective action cost estimate reviewed and approved by the appropriate RWQCB.

(1) The operator of each disposal facility required to demonstrate financial responsibility to undertake a corrective action program must have a detailed written estimate, in current dollars, of the cost of hiring a third party to perform the corrective action in accordance with the program required under Article 1, Subchapter 3, Chapter 3 (§20380 et seq.). The corrective action cost estimate must account for the total costs of corrective action activities as described in the corrective action plan for the entire corrective action period.

(2) The operator must annually adjust the estimate for inflation until the corrective action program is completed in accordance with Article 1, Subchapter 3, Chapter 3 (§20380 et seq.).

(3) The operator must increase the corrective action cost estimate and the amount of financial assurance provided under .(a) if changes in the corrective action program or disposal facility conditions increase the maximum costs of corrective action.

(4) The operator may reduce the amount of the corrective action cost estimate and the amount of financial assurance provided under .(a) if the cost estimate exceeds the maximum remaining costs of corrective action. The operator must receive authorization from the CIWMB approving the reduction of the corrective action cost estimate before adjusting the financial mechanism used to demonstrate coverage.

Note: Authority cited: Sections 40502 and 40508, Public Resources Code Reference: Sections 40508 and 43103, Public Resources Code; Section 258.73, Title 40, Code of Federal Regulations.

22222. SWRCB - Corrective Action Funding Requirements. [C15: §2550.0(b) and §2580(f)]

The requirements of this section apply to dischargers who own or operate a Class II or Class III waste management unit (Unit). This section does not apply to discharges of mining waste to mining waste management units (mining Units). [Note: The requirements of this paragraph do not preclude the RWQCB (under authority other than this subdivision) from requiring financial assurance for a known or reasonably foreseeable release at a mining Unit.] At Units for which the CIWMB does not require financial assurances for corrective action, the RWQCB shall require the discharger to establish an irrevocable fund (or to provide other means) pursuant to the CIWMB-promulgated sections of this chapter but with the RWQCB named as beneficiary, to ensure funds are available to address a known or reasonably foreseeable release from the Unit, pursuant to §20380(b). For addressing a known or reasonably foreseeable release at a solid waste landfill, the RWQCB shall coordinate with the CIWMB, pursuant to §20380(b) and in a manner consistent with §20950(f).

Subchapter 3. Allowable Mechanisms
Article 1. CIWMB - General Requirements for Mechanisms
.22225. Minimum Closure and/or Postclosure Maintenance and/or Reasonably Foreseeable Corrective Action Fund Balance Calculation. (T14-§18282)
(a) Except as provided in (b), and §22228, an operator using a trust fund or an enterprise fund to demonstrate financial responsibility for closure and/or postclosure maintenance and/or reasonably foreseeable corrective action costs shall maintain a fund balance equal to or exceeding the amount specified by the following provisions:

(1) By each anniversary date of the establishment of the fund, the operator shall submit the following information to the CIWMB. The estimates shall be consistent with the information in the solid waste landfill’s current Report of Disposal Site Information specified in §21680, and/or the most recently submitted closure plan, or postclosure maintenance plan, and/or reasonably foreseeable corrective action cost estimate.

(A) A demonstration of the minimum fund balance calculation as required in (a)(2);
(B) The annual capacity filled during the past year;
(C) The cumulative capacity filled;
(D) The remaining cost estimate;
(E) The remaining permitted capacity; and
(F) The total permitted capacity.

(2) On each anniversary date of the establishment of the fund, the minimum fund balance shall be increased by the quantity determined by the following formulas:

(A) For anniversary dates that occur before December 31, 1993, the minimum deposit is calculated by,

\[
(C_r/C_t) \times E = \text{minimum deposit},
\]

where \( C_r \) is the annual capacity filled, \( C_t \) is the total permitted capacity, and \( E \) is the current closure and/or postclosure cost and/or reasonably foreseeable corrective action costs estimate(s) covered by the fund; and

(B) For anniversary dates that occur on or after December 31, 1993, the minimum deposit is calculated by,

\[
(C_r/C_t) \times E_r = \text{minimum deposit},
\]

where \( C_r \) is the annual capacity filled, \( C_t \) is the remaining permitted capacity, \( E_r \) is the remaining closure and/or postclosure cost and/or reasonably foreseeable corrective action costs estimate(s) to be funded.

(3) The fund must be fully funded by the time the last shipment of waste has been received at the disposal facility.

(4) The CIWMB may approve a change of the anniversary date of the establishment of the fund only once, and at the written request of the operator. The operator may execute the anniversary date change only after the CIWMB has approved the change.

(b) If an operator establishes a trust fund or enterprise fund after using one or more alternate mechanisms specified in this Article, the initial payment into the fund must be at least the amount that the fund would contain if the trust fund or enterprise fund were established initially and annual payments were made according to the formula(s) specified in this section.

(T14:§17258.74)  
(a) An operator using a trust fund or an enterprise fund to demonstrate financial responsibility for known corrective action costs shall maintain a fund balance equal to or exceeding the amount specified by the following provisions:  

(1) Payments into the known corrective action fund must be made annually by the operator over one-half of the estimated length of the known corrective action program. This period is referred to as the pay-in period.  

(2) For a trust fund or enterprise fund used to demonstrate financial assurance for corrective action, the first payment into the fund must be at least equal to one-half of the current cost estimate for corrective action, divided by the number of years in the corrective action pay-in period as defined in .(a)(1). The amount of subsequent payments must be determined by the following formula:  

\[
\text{Next Payment: } \frac{\text{RB-CV}}{Y} \]  

where RB is the most recent estimate of the required fund balance for corrective action (i.e., the total costs that will be incurred during the second half of the corrective action period), CV is the current value of the fund, and Y is the number of years remaining in the pay-in period.  

(3) The initial payment into the fund must be made no later than 120 days after the corrective action remedy has been selected in accordance with the requirements of Article 1, Subchapter 3, Chapter 3 (§20380 et seq.).  

(4) If the operator establishes a fund after having used one or more alternate mechanisms specified in this Subchapter, the initial payment into the fund must be at least the amount that the fund would contain if the fund were established initially and annual payments made according to the specifications of this section.  

(5) The fund may be terminated by the operator only if the operator substitutes alternate financial assurance as specified in this Subchapter or is no longer required to demonstrate financial responsibility in accordance with the requirements of Article 4 of Subchapter 2 of this Chapter.  


.22227. CIWMB - Substitution of Mechanisms. (T14:§18241,18293)  
(a) An operator may substitute any alternate financial assurance mechanism(s) acceptable to the CIWMB as specified in this Subchapter, provided that at all times the operator maintains an effective mechanism or a combination of effective mechanisms that satisfies the applicable requirements of this Subchapter.  

(b) After obtaining alternate financial assurance, an operator may request that the CIWMB terminate or authorize the termination of a financial assurance mechanism. The operator shall submit such a request in writing with evidence of alternate financial assurance.  

(c) Following approval by the CIWMB, the operator may cancel a financial assurance mechanism by giving notice to the provider of financial assurance.  


.22228. CIWMB - Acceptable Mechanisms and Combination of Mechanisms.  
(T14:§17258.74,18233,18283)  
(a) Subject to the limitations and conditions of .(b) through .(j), an operator shall use any one, or any combination of mechanisms as described in Article 2 of this Subchapter:  

(1) §22240, Trust Fund;
(2) §22241, Enterprise Fund;
(3) §22242, Government Securities;
(4) §22243, Letter of Credit;
(5) §22244, Surety Bond;
(6) §22245, Pledge of Revenue;
(7) §22246, Financial Means Test;
(8) §22247, Guarantee;
(9) §22248, Closure and/or Postclosure Maintenance and/or Reasonably Foreseeable Corrective Action Costs Insurance;
(10) §22249, Local Government Financial Test;
(11) §22249.5, Local Government Guarantee;
(12) §22250, Federal Certification;
(13) §22251, Liability Insurance;
(14) §22252, Self-Insurance and Risk Management;
(15) §22253, Insurance and Environmental Fund; and
(16) §22254, State Approved Mechanism.

(b) Any mechanism(s) used to demonstrate financial responsibility shall be updated within 60 days after changes are made in the amount of any current closure or postclosure cost estimate or third party liability coverage requirement or corrective action cost estimate covered by the mechanism(s).

(c) If a combination of mechanisms as described in Article 2 of this Subchapter are chosen, the operator shall designate one mechanism as "primary" and all others as "excess" coverage.

(d) If an operator combines a trust fund and/or an enterprise fund with any other mechanism to cover closure costs and/or postclosure maintenance costs and/or third party operating liability coverage requirements and/or corrective action costs, the operator may only use the fund buildup authorized by §22225 and/or §22226, for the portion of closure and/or postclosure maintenance costs and/or corrective action costs covered by the trust fund and/or enterprise fund.

(e) The enterprise fund, government securities, local government financial test, and self-insurance and risk management mechanisms are acceptable only for disposal facilities operated by government agencies. A local government guarantee and a pledge of revenue may be used by an operator or provider of financial assurances that is a government agency for a disposal facility to demonstrate financial responsibility for postclosure maintenance and/or corrective actions.

(f) An operator shall not combine a performance bond or a performance local government guarantee with any other mechanism(s) for closure, for postclosure maintenance, or for corrective action.

(g) The financial means test and guarantee mechanisms are acceptable only for disposal facilities operated by private firms. A private operator may combine a financial means test with a guarantee only if, for the purpose of meeting the requirements of the financial means test, the financial statements of the operator are not consolidated with the financial statements of the guarantor.

(h) The insurance and environmental fund mechanism shall not be combined with any other mechanisms identified in .(a).

(i) The Federal Certification mechanism provided in §22250 shall only be used by federal entities.
(j) A government agency may act as a provider of financial assurance for a disposal facility by using a pledge of revenue to demonstrate financial responsibility for postclosure maintenance on behalf of a private operator, if either:

(1) The agency owns the facility; or

(2) The agency is the rate setting authority and has control of the waste stream in the jurisdiction where the disposal facility is located.

(k) A government agency may provide a local government guarantee for a disposal facility of another government agency or private company.

NOTE: Authority cited: Sections 40502, and 43040, and 43601.5, Public Resources Code. References: Sections 43040, 43103, and 43500 through 43610 43610.1, Public Resources Code, Part 258.74(f) and (h), Title 40 Code of Federal Regulations.

.22229. CIWMB - Use of Multiple Mechanisms. (T14:§17258.74)
(a) An operator may satisfy the requirements of this Chapter by establishing more than one financial mechanism per disposal facility. The mechanisms must be as specified in Article 2 of this Subchapter, except that it is the combination of mechanisms, rather than the single mechanism, which must provide financial assurance for an amount at least equal to the current coverage requirement of Subchapter 2.


.22230. CIWMB - Use of Mechanism(s) for Multiple Facilities. (new)
(a) An operator may use one or more of the financial assurance mechanisms specified in Article 2 of this Subchapter, to provide financial assurance for more than one disposal facility. The amount of funds provided shall be no less than the sum of funds that would be available if a separate mechanism had been established and maintained for each disposal facility. In directing funds for designated activities of any of the disposal facilities covered by the mechanism(s), only the amount of funds designated for that activity at that disposal facility may be used.


.22231. CIWMB - Cancellation or Nonrenewal by a Provider of Financial Assurance. (T14:§17258.74,§18242,18294)
(a) Except as otherwise provided in §22232, a provider of financial assurance may cancel or not renew a financial assurance mechanism by sending a notice of termination by certified mail to the operator, and the CIWMB.

(1) Termination of a letter of credit, a surety bond, an insurance policy, or a guarantee shall not occur until 120 days after the date on which the operator, and the CIWMB have received the notice of termination, as evidenced by the return receipts.

(2) If a provider of financial assurance cancels or fails to renew a mechanism for reasons other than its bankruptcy or incapacity, the operator shall obtain alternate coverage within 60 days after receiving the notice of termination. If the operator fails to obtain alternate coverage within the 60 days, the operator shall notify the CIWMB of such failure.

(b) The closure and/or postclosure maintenance and/or reasonably foreseeable corrective action costs insurance policy, issued in accordance with §22248, shall provide that the insurer may not cancel, terminate or fail to renew the policy except for failure to pay the premium. The automatic renewal of the policy shall, at a minimum, provide the insured with the option of renewal at the face amount of the expiring policy. If there is a failure to pay the
premium, the insurer may cancel the policy by sending notice of cancellation by certified mail to the operator, and the CIWMB 120 days in advance of cancellation. If the insurer cancels the policy, the operator must obtain alternate financial assurance as specified in §22228. If the operator fails to demonstrate alternate financial assurance as specified in §22228 within 60 days after receiving the notice of termination, the CIWMB may allow the insurer an extension to the term of the insurance policy for a period of time shorter than one year. Cancellation, termination, or failure to renew will not occur and the policy will remain in full force and effect in the event that on or before the date of expiration:

(1) The CIWMB or enforcement agency deems the disposal facility abandoned; or
(2) The permit is terminated or revoked or a new permit is denied by the CIWMB or enforcement agency; or
(3) Closure is ordered by the CIWMB, or any other state or federal agency, or a court of competent jurisdiction; or
(4) The operator is named as a debtor in a voluntary or involuntary proceeding under Title 11 (Bankruptcy) U.S. Code; or
(5) All delinquent premium payments have been brought current.

c. Cancellation or nonrenewal of third party operating liability insurance or self-insurance and risk management for third party operating liability coverage shall occur no less than 60 days after the date on which the operator, and the CIWMB have received the notice of termination, as evidenced by the return receipts; except in the case of non-payment of insurance premiums, in which case cancellation shall occur no less than 10 days after the date on which the operator, and the CIWMB have received the notice of termination.


.22232. CIWMB - Bankruptcy or Other Incapacity of Operator or Provider of Financial Assurance. (T14§18243,18295)
(a) Within 10 days after commencement of a voluntary or involuntary proceeding under the Bankruptcy Code, Title 11 U.S.C. sections 101-1330 in which:

(1) The operator is named as debtor, the operator shall notify the CIWMB by certified mail of such commencement.
(2) A provider of financial assurance is named as debtor, such provider shall notify the operator, and the CIWMB certified mail of such commencement.
(b) An operator shall be deemed to be without the required financial assurance in the event of bankruptcy of its provider of financial assurance, or in the event of a suspension or revocation of the authority of the provider of financial assurance to issue a mechanism. If such an event occurs, the operator shall demonstrate alternate financial assurance as specified in this Article within 60 days after receiving notice of the event. If the operator fails to obtain alternate financial assurance within 60 days, the operator shall notify the CIWMB within 10 days of such failure.


.22233. CIWMB - Record Keeping and Reporting. (T14§18244,18297)
(a) An operator shall maintain evidence of all financial assurance mechanisms until the operator is released from the requirements as specified in §22235. This evidence shall be maintained at each disposal facility, whenever possible, or at an alternate, designated location approved by the CIWMB and which is accessible to the operator, and available for CIWMB staff review.
(b) An operator shall maintain the following types of evidence, and an original or copy of each mechanism used to demonstrate financial responsibility under this Chapter and documentation of the estimated total permitted capacity of the solid waste landfill.

(1) Trust Fund. An operator using a trust fund shall maintain documentation of the remaining capacity filled during the past year for each disposal facility covered by the fund for each year of the buildup period and a copy of the trust agreement and statements verifying the current balance of the fund.

(2) Enterprise Fund. An operator using an enterprise fund shall maintain documentation of the remaining capacity filled during the past year for each disposal facility covered by the fund for each year of the buildup period and a copy of the following:

(A) All official resolutions, forms, letters, or other pertinent documents generated to establish the fund;

(B) The annual financial statements of the fund; and

(C) With respect to the financial assurance mechanism into which enterprise fund revenue is deposited:

1. Identify the disposal facilities and the current closure and/or postclosure costs estimate(s) and/or third party operating liability coverage requirement and/or corrective action cost estimate(s) covered by the mechanism;

2. Include a letter from an authorized officer of the institution maintaining the mechanism identifying the amount of coverage provided by the mechanism as of the date of its establishment and each anniversary date of establishment; and

3. Include a copy of the evidence documenting that the mechanism meets the requirements of §22241.

(3) Government Securities. An operator using government securities shall maintain a copy of the following:

(A) All official resolutions, forms, letters, or other pertinent documents generated to issue the securities;

(B) The terms of issuance of the securities; and

(C) With respect to the mechanism into which the funds generated by the issuance are deposited, the information listed in §22233(b)(2)(C)(1), 2 and 3.

(4) Pledge of Revenue Agreement. An operator using a pledge of revenue shall do both of the following:

(A) Maintain a copy of the following:

1. All official resolutions, forms, letters, and other pertinent documentation generated to authorize the pledge of revenue;

2. The agreement between the CIWMB and the operator or provider of financial assurance as specified in §22245; and

3. Documentation that the pledged revenue will be available in a timely manner to pay postclosure maintenance costs.

(B) Submit to the CIWMB, at least annually in conjunction with the adjustment of cost estimates pursuant to §22236, a demonstration that the pledge is still in effect.

(5) Financial Means Test. An operator using a financial means test shall maintain a copy of the information specified in §22246.

(6) Guarantee. An operator using a guarantee shall maintain documentation of the guarantor's qualifications for providing a guarantee under §22246 and §22247.

(7) Closure and/or Postclosure Maintenance and/or Reasonably Foreseeable Corrective Action Costs Insurance. An operator using closure and/or postclosure maintenance and/or reasonably foreseeable corrective action costs insurance shall maintain a copy of the insurance certificate submitted to the CIWMB, the insurance policy and any endorsements thereon.
8. Operating Liability Insurance. An operator using third party operating liability insurance shall maintain the original or a copy of the insurance policy in addition to the original or a copy of the liability insurance endorsement or the certificate of liability insurance.

9. Self-Insurance and Risk Management. An operator using self-insurance and risk management shall maintain:

   (A) The name and qualifications of the currently employed risk manager;

   (B) Pertinent documents verifying the ongoing activity of the operator's safety and loss prevention program; and

   (C) Pertinent documents showing procedures for timely investigation and resolution of any claims for third party damages caused by accidental occurrences and other self-insured losses.

10. Insurance and Environmental Fund. An operator using the insurance and environmental fund shall maintain the original or a copy of the comprehensive general liability insurance coverage certification and a copy of the environmental liability fund agreement and statements verifying the current balance of the environmental liability fund. If self-insurance and risk management is utilized for the insurance coverage, documentation shall be maintained as identified in .(9).

11. Local Government Financial Test. An operator using a local government financial test shall maintain a copy of the information specified in §22249.

12. Local Government Guarantee. An operator using a guarantee shall maintain documentation of the guarantor's qualifications for providing a guarantee under §22249 and §22249.5.

   (c) An operator shall submit the documentation of current evidence of financial responsibility listed in .(b) to the CIWMB whenever a financial assurance mechanism is established or amended or canceled or not renewed for any reason:

   (1) In the case of a trust fund such documentation shall include the original mechanism and a copy of the current statement verifying the balance of the account;

   (2) In the case of government securities such documentation shall include the information as specified in .(b)(3);

   (3) In the case of a letter of credit, surety bond, closure and/or postclosure maintenance and/or reasonably foreseeable corrective action costs insurance, financial means test, or guarantee, such documentation shall include the original mechanism and all amendments;

   (4) In the case of insurance or self-insurance and risk management for third party operating liability coverage, such documentation shall include the original insurance endorsement, certificate of insurance, certificate of self-insurance and risk management, and any endorsements thereon;

   (5) In the case of the insurance and environmental liability fund, the insurance or self-insurance and risk management documentation shall include the original certification of comprehensive general liability insurance, or certification of self-insurance and risk management. The documentation for the environmental liability fund shall include the original environmental liability fund agreement and a copy of the current statement verifying the balance of the account, as specified in §22253.

   (d) An operator shall annually submit written notice to the CIWMB of the number of claims paid and the total dollar amount paid as a result of any accidental occurrences at the disposal facility. This information shall be compiled for the previous calendar year and submitted to the CIWMB by March 1st of each year.

NOTE: Authority cited: Sections 40502, 43040, and 43604.5, Public Resources Code. References: Sections 43040, 43103, and 43500 through 43610.1, Public Resources Code, Part 258.74(f) and (h), Title 40 Code of Federal Regulations.

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.22234. CIWMB - Disbursements from Financial Mechanisms. (T14:§17258.74)
(a) The operator, or other person authorized to conduct closure, postclosure maintenance, or corrective action activities, may request disbursements from the CIWMB for these expenditures. Requests for disbursement will be granted by the CIWMB only if:

(1) Sufficient funds are remaining in the financial mechanism(s) to cover the remaining costs of closure, postclosure maintenance, or corrective action; and

(2) Justification and documentation of the cost is presented to the CIWMB for review and approval in conjunction with approved final closure and postclosure maintenance plans, or an approved corrective action plan.

(b) The CIWMB shall authorize disbursements from an established closure or postclosure maintenance financial assurance mechanism to the RWQCB for the costs of closure or postclosure maintenance if the RWQCB finds that the operator has failed to perform closure or postclosure maintenance as required by the closure plan or postclosure maintenance plan as approved by the RWQCB and the CIWMB, or as required by an Order issued by the RWQCB, including Waste Discharge Requirements (WDRs), Cease and Desist Orders (CDOs), and/or Cleanup and Abatement Orders (CAOs).

(c) The CIWMB shall authorize disbursements from an established corrective action financial assurance mechanism to the RWQCB for the costs of corrective action if the RWQCB finds that the operator has failed to perform corrective action as required by the corrective action workplan as approved by the RWQCB and the CIWMB, or as required by an Order issued by the RWQCB, including WDRs, CDOs, and/or CAOs.


.22235. CIWMB - Release of Financial Assurance Requirements. (T14:§18245,18298)
(a) After receiving and approving certification of closure from the operator as specified by §21880, the CIWMB shall notify the operator and the provider of financial assurance in writing, that he or she is no longer required to demonstrate financial responsibility for closure and third party operating liability claims, pursuant to this Chapter, at the particular disposal facility pursuant to this Article.

(b) When operational control of a disposal facility is transferred, the existing operator shall remain subject to the requirements of this Chapter until the new operator provides acceptable financial assurances to the CIWMB.

(c) When the CIWMB determines that an operator has completed postclosure maintenance in accordance with the applicable postclosure plan, the CIWMB shall notify the operator in writing that it is no longer required to maintain financial assurance for postclosure maintenance of the particular solid waste landfill pursuant to this Chapter.

(d) When the CIWMB releases an operator that is using a trust fund or a similar financial assurance mechanism in conjunction with an enterprise fund or government securities from the requirements of this Chapter, the CIWMB shall authorize the termination of the trust fund or the similar mechanism.


.22236. CIWMB - Annual Inflation Factor. (T14:§18272)
The operator shall submit, by June 1 of each year, a report calculating the increase in the cost estimates for closure and/or postclosure maintenance and/or corrective action due to the inflation factor for the previous calendar year. The inflation factor is derived from the annual Implicit Price Deflator for Gross National Product as published annually by the U.S. Department of Commerce in its Survey of Current Business, which is incorporated by reference. The inflation factor is the result of dividing the latest annual published deflator by the deflator for the previous year. The operator shall increase the monetary amount of the financial mechanism required under this Chapter based upon this inflation factor. The mechanism may not be decreased other than as a result of the closure and/or postclosure maintenance and/or corrective action plan amendment process.

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.22237. CIWMB - Depository Trust Fund. (T14 §18296)
(a) The CIWMB may require an operator using a letter of credit, a surety bond, or, as applicable, a financial assurance mechanism used in conjunction with an enterprise fund or with government securities, to establish a depository trust fund meeting the requirements of .(c) if:

(1) The operator fails to demonstrate alternate financial assurance within 60 days after receiving notice of cancellation of the mechanism; or

(2) The operator fails to perform closure or postclosure maintenance or corrective action in accordance with the applicable approved closure or postclosure maintenance plan and permit requirements or corrective action requirements of Article 1, Subchapter 3, Chapter 3 ($20380 et seq.), when required to do so by the CIWMB or RWQCB and, in the case of a performance bond, the surety company fails to perform such activities on behalf of the operator.

(b) The CIWMB may require an institution issuing a letter of credit, a surety company, or, as applicable, a provider of a financial assurance mechanism used in conjunction with an enterprise fund or government securities to:

(1) Establish a depository trust fund meeting the requirements of .(c) if the operator fails to establish a depository trust fund as required by .(a); and

(2) Place into the depository trust fund an amount of funds, stipulated by the CIWMB, up to the limit of funds provided by the financial assurance mechanism.

(c) The depository trust fund shall meet the requirements of §22240.

(d) The CIWMB may draw on the depository trust fund as specified by the trust agreement.

(e) If, at any time, due to interest earned or over deposit, the value of the depository trust fund is greater than the required amount of coverage minus the amount of coverage demonstrated by other mechanisms, the provider of financial assurance that established the depository trust fund may request in writing that the CIWMB authorize the release of the excess funds. No later than 60 days after receiving such a request, the CIWMB will review the request and, if any excess funds are verified, will instruct the trustee to release the funds.


Article 2. CIWMB - Financial Assurance Mechanisms
.22240. CIWMB - Trust Fund. (T14 §17258.74, 18234,18284)
(a) The trust fund shall have a trustee that is authorized to act as a trustee and whose trust operations are regulated and examined by a federal or state agency.

(b) The trust agreement shall be worded as specified by and established by using Form CIWMB 100 (4/96) which is incorporated by reference, with appropriate amendments to identify that the mechanism is utilized for closure and/or postclosure maintenance and/or third party operating liability and/or corrective action.

(c) If, at any time, the value of the trust fund is greater than the required amount of coverage minus the amount of coverage demonstrated by another mechanism, the operator may request in writing that the CIWMB authorize the release of the excess funds. The CIWMB shall review the request within 90 days of receipt of the request. If any excess funds are verified, the CIWMB shall instruct the trustee to release the funds.

22241. CIWMB - Enterprise Fund. (T14:§18285)
(a) The enterprise fund shall dedicate its revenue exclusively or with exclusive first priority to financing closure and/or postclosure maintenance and/or corrective action.

(b) Revenue generated by an enterprise fund shall be deposited into a financial assurance mechanism that the operator demonstrates, to the satisfaction of the CIWMB, meets the following requirements:

1. The mechanism will provide equivalent protection to a trust fund in ensuring that the assured amount of funds shall be available in a timely manner for closure and/or postclosure maintenance and/or corrective action;

2. The revenue deposited into the mechanism will be used exclusively to finance closure and/or postclosure maintenance and/or corrective action, as applicable, and will remain inviolate against all other claims, including any claims by the operator, the operator's governing body, and the creditors of the operator and its governing body;

3. The mechanism authorizes the CIWMB to direct the provider of financial assurance to pay closure or postclosure maintenance or corrective action costs if the CIWMB determines that the operator has failed or is failing to perform closure or postclosure maintenance or corrective action activities, as applicable, as covered by the mechanism;

4. The financial operations of the provider of the financial assurance are regulated by a federal or state agency, or the provider is otherwise certain to maintain and disburse the assured funds properly;

5. If the provider of financial assurance has authority to invest revenue deposited into the mechanism, the provider shall exercise investment discretion similar to a trustee; and

6. The mechanism meets other requirements that the CIWMB determines are needed to ensure that the assured amount of funds shall be available in a timely manner for closure and/or postclosure maintenance and/or corrective action.


22242. CIWMB - Government Securities. (T14:§18235,18286)
(a) The terms of issuance of government securities shall specify that proceeds from the sale of the securities shall be deposited into a financial assurance mechanism that meets the requirements of . (b).

(b) The securities shall have been issued and the proceeds already deposited into the financial assurance mechanism that provides equivalent protection to a trust fund by meeting the following requirements:

1. Proceeds from the sale of securities shall be used exclusively and only as applicable, to:

   A. Pay costs of closure activities identified in the most recently approved closure plan; and/or

   B. Pay costs of postclosure maintenance identified in the most recently approved postclosure maintenance plan; and/or

   C. Pay claims by third parties for bodily injury and property damage caused by accidental occurrences; and/or

   D. Pay costs of corrective action activities in the most recently approved corrective action plan; and

   E. All funds shall remain inviolate against all other claims, including any claims by the operator, the operator's governing body, and the creditors of the operator and its governing body;

2. The financial operations of the provider of the financial assurance shall be regulated by a federal or state agency, or the provider shall be otherwise certain to maintain and disburse the assured funds properly;

3. If the provider of financial assurance has authority to invest revenue deposited into the mechanism, the provider shall exercise investment discretion similar to a trustee; and
(4) The mechanism meets other reasonable requirements that the CIWMB determines are necessary to ensure that the assured funds shall be available in a timely manner.


.22243. CIWMB - Letter of Credit. (T14:§17258.74, 18287)

(a) The institution issuing a letter of credit shall have the authority to issue letters of credit and its letter-of-
credit operations shall be regulated and examined by a federal or state agency.

(b) The letter of credit shall be worded and completed, with appropriate amendments to identify that the mechanism is utilized for closure and/or postclosure maintenance and/or corrective action costs, as specified by form CIWMB 101 (4/96) which is incorporated by reference. The original mechanism must be submitted to the CIWMB.

(c) The letter of credit shall be accompanied by a letter from the operator identifying the number, issuing
institution, and date of issuance of the letter of credit and the name, address, solid waste information system
number, and amount of funds assured by the letter of credit for closure and/or postclosure maintenance and/or corrective action for each solid waste landfill. If the letter of credit is for more than one coverage requirement and/or for more than one solid waste landfill, appropriate sublimits must also be clearly identified within the letter of credit.

(d) The letter of credit shall be irrevocable and shall be issued for a period of at least one year, except as noted in .(d)(2).

(1) The letter of credit shall provide that the expiration date will be automatically extended for a period of at least one year, unless the issuing institution provides notice of termination as specified in §22231.

(2) If an operator fails to demonstrate alternate coverage within 60 days after receiving a notice of termination, the CIWMB may allow an issuing institution an extension to the term of a letter of credit for a period of time shorter than one year.

(e) The issuing institution shall become liable under the terms of the letter of credit if the CIWMB determines that the operator has failed or is failing to perform closure or postclosure maintenance or corrective action activities as guaranteed by the mechanism.

(f) The operator may cancel the letter of credit only if alternate financial assurance is substituted as specified in §22227 or if the operator is released from the requirements of this section in accordance with §22235.


.22244. CIWMB - Surety Bond. (T14:§17258.74, 18288)

(a) The status of the surety company issuing a surety bond shall be among those listed as holding certificates of authority as acceptable sureties on Federal bonds and as acceptable reinsuring companies in Circular 570 of the U.S. Department of the Treasury which is published on July 1 of each year in the Federal Register.

(b) The penal sum of the bond must be in an amount at least equal to the closure and/or postclosure and/or the corrective action cost estimate, except as provided in §22228.

(c) The surety bond shall be worded and completed as specified by one of the following forms, which shall be supplied by the CIWMB. The original mechanism must be submitted to the CIWMB:

(1) Form CIWMB 102(a) (4/96) which is incorporated by reference, for a surety bond guaranteeing performance of closure; or

(2) Form CIWMB 102(b) (4/96) which is incorporated by reference, for a surety bond guaranteeing performance of postclosure maintenance; or
(3) Form CIWMB 102(a) (4/96) which is incorporated by reference, for a surety bond guaranteeing performance of reasonably foreseeable and/or known corrective action activities; or

(4) Form CIWMB 103(a) (4/96) which is incorporated by reference, for a surety bond guaranteeing payment of closure costs; or

(5) Form CIWMB 103(b) (4/96) which is incorporated by reference, for a surety bond guaranteeing payment of postclosure maintenance costs; or

(6) Form CIWMB 103(c) (4/96) which is incorporated by reference, for a surety bond guaranteeing payment of reasonably foreseeable and/or known corrective action costs.

(d) The surety company shall become liable under the terms of the bond if the CIWMB determines that the operator has failed or is failing to perform closure or postclosure maintenance or corrective action as guaranteed by the bond.

(e) Payments made under the terms of the bond will be deposited by the surety directly into the depository trust fund, as identified in §22237.

(f) The operator may cancel the bond only if alternate financial assurance is substituted as specified in §22227 or if the operator is no longer required to demonstrate financial responsibility in accordance with §22235.


22245. CIWMB - Pledge of Revenue. (T14:§18290)
(a) A pledge of revenue shall consist of a resolution by the governing body of the operator or provider of financial assurance authorizing an agreement between the operator or provider of financial assurance and the CIWMB to establish the pledge. The resolution and the agreement shall remain effective continuously throughout the period in which the pledge of revenue is used to satisfy the requirements of Subchapter 2 of this Chapter.

(b) The agreement establishing the pledge of revenue shall contain the following items:

(1) The types and sources of pledged revenue;

(2) The amount of revenue pledged from each source;

(3) The period of time that each source of revenue is pledged to be available; and

(4) The solid waste landfill(s) and the current postclosure and/or corrective action cost estimate(s) that are covered by the pledge.

(5) The authorization for the CIWMB to direct payment for postclosure maintenance and/or corrective action if the CIWMB determines that the operator has failed or is failing to perform postclosure maintenance or corrective action activities covered by the mechanism.

(c) An operator or provider of financial assurance shall pledge the following types of revenue that the operator or provider of financial assurance controls and that will be available in a timely manner to pay for postclosure maintenance or corrective action:

(1) User fees, rents, or other guaranteed revenue from existing or planned solid waste facilities;

(2) Tax increases within statutory limitations; and/or

(3) Other guaranteed revenues that are acceptable to the CIWMB.

(d) If an operator or provider of financial assurance ceases at any time to retain control of its ability to allocate any pledged revenue to pay postclosure maintenance or corrective action costs, the operator or provider of financial assurance shall notify the CIWMB and shall obtain alternate coverage within 60 days after control lapses.

22246. CIWMB - Financial Means Test. (T14:§18238, 18289)
(a) To pass the financial means test, an operator or a guarantor shall be a private entity and shall meet the criteria of (d), (e), (f) or (g) based on independently audited year-end financial statements for the latest completed fiscal year.

(b) The phrase "amount of liability coverage to be demonstrated by the test" as used in (d) and (e) refers to the amount of liability coverage required by §22216.

(c) The phrase "current cost estimates covered by the test" as used in (f) and (g) refers to the current postclosure cost estimate required by (h)(1) to be shown in paragraphs 1 and 2 of the letter from the chief financial officer.

(d) To cover operating liability the operator or guarantor shall have:
   (1) Net working capital and tangible net worth each at least six times the amount of liability coverage to be demonstrated by the test; and

   (2) Tangible net worth of at least $10 million; and

   (3) Assets located in the United States amounting to at least 90 percent of its total assets or at least six times the amount of liability coverage to be demonstrated by the test.

(e) To cover operating liability the operator or guarantor shall have:
   (1) A current rating for its most recent bond issuance of AAA, AA, A, or BBB issued by Standard and Poor's or Aaa, Aa, A, or Baa as issued by Moody's; and

   (2) Tangible net worth of at least six times the amount of liability coverage to be demonstrated by the test; and

   (3) Tangible net worth of at least $10 million; and

   (4) Assets located in the United States amounting to at least 90 percent of its total assets or at least six times the amount of liability coverage to be demonstrated by the test.

(f) To cover postclosure maintenance the operator or guarantor shall have:
   (1) Two of the following three ratios: a ratio of total liabilities to net worth that is greater than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities that is greater than 0.1; and a ratio of current assets to current liabilities that is greater than 1.5; and

   (2) Net working capital and tangible net worth each at least six times the sum of the current cost estimate covered by the test; and

   (3) Tangible net worth of at least $10 million; and

   (4) Assets located in the United States amounting to at least 90 percent of its total assets or at least six times the sum of the current cost estimate covered by the test.

(g) To cover postclosure maintenance the operator or guarantor shall have:
   (1) A current rating for its most recent bond issuance of AAA, AA, A, or BBB issued by Standard and Poor or Aaa, Aa, A, or Baa as issued by Moody's; and

   (2) Tangible net worth at least six times the sum of the current cost estimate covered by the test, and

   (3) Tangible net worth of at least $10 million and

   (4) Assets located in the United States amounting to at least 90 percent of its total assets or at least six times the sum of the current cost estimate covered by the test.

(h) Within 90 days after the close of each financial reporting year, the operator or the guarantor shall submit the following items to the CIWMB and, in the case of a guarantor, to the operator;
(1) A letter on the operator's or guarantor's official letterhead stationary that is worded and completed as specified in form CIWMB 104 (4/96) which contains an original signature of the operator's or guarantor's chief financial officer.

(A) An operator or guarantor shall use form CIWMB 104 (4/96) to demonstrate or guarantee financial responsibility for liability coverage only or postclosure costs only or both liability and postclosure maintenance. If the operator or guarantor is using a similar financial means test to demonstrate liability coverage and/or postclosure maintenance for facilities in other states, the operator shall list those out-of-state facilities, as well as the California facilities on this test.

(2) A copy of an independent certified public accountant's report on examination of the operator's or guarantor's financial statements for the latest completed fiscal year, with a copy of the operator's or guarantor's financial statements for the latest completed fiscal year.

(3) A letter from an independent certified public accountant stating that:

(A) He or she has compared the data in the letter in .(h)(1), from the chief financial officer specified as having been derived from the financial statements for the latest completed fiscal year of the operator or the guarantor, with the amounts in the financial statements; and

(B) Based on the comparison, no matters came to his or her attention that caused him or her to believe that the specified data should be adjusted.

(4) If the operator or the guarantor is required to make such a filing, a copy of the operator's or guarantor's most recent form 10-K filed with the U.S. Securities and Exchange Commission.

(i) The CIWMB may require updated financial statements at any time from the operator or guarantor. If the CIWMB finds that the operator or guarantor no longer meets the financial means test requirements of .(d),(e),(f), or (g) based on such reports or other information, including but not limited to, credit reports and reports from other state agencies, the operator shall obtain alternate coverage within 60 days after receiving the notification of such a finding.

(j) If, at the time of its annual filing, an operator using the financial means test fails to meet the requirements of the financial means test under .(d),(e),(f), or (g), the operator shall obtain alternate coverage within 60 days after the determination of such failure.

(k) If the operator fails to obtain alternate coverage within the times specified in .(i) or (j), the operator shall notify the CIWMB by certified mail within 10 days of such failure.


.22247. CIWMB - Guarantee. (T14:§18239, 18291)

(a) The guarantor shall be:

(1) A parent corporation of the operator;

(2) A firm whose parent corporation is also the parent corporation of the operator; or

(3) A firm engaged in a substantial business relationship with the operator and issuing the guarantee as an act incident to that business relationship.

(b) The guarantor shall meet the requirements of the financial means test under §22246 of this Article based on the guarantor's audited year-end financial statements.

(c) The guarantee shall be worded and completed as specified by form CIWMB 105 (4/96), which is incorporated by reference.

(d) The terms of the guarantee shall specify that if:

(1) The operator fails or is failing to perform postclosure maintenance in accordance with the applicable approved postclosure maintenance plan when required to do so, the guarantor shall either:
(A) Perform postclosure maintenance in accordance with the applicable approved postclosure maintenance plan; or

(B) Establish and fund a trust fund, as specified in §22240, in the name of the operator in the amount of the applicable current postclosure maintenance cost estimate covered by the guarantee.

(2) The operator fails to satisfy a judgment or an award for bodily injury and property damage to third parties caused by accidental occurrences, or fails to pay an amount agreed in settlement of a claim arising from or alleged to arise from such injury and damage, the guarantor shall satisfy such judgment, award, or settlement agreement up to the limits of the guarantee.

(e) If the guarantor fails to meet the requirements of the financial means test under §22246 or wishes to terminate the guarantee, the guarantor shall send notice of such failure or termination by certified mail to the operator, and the CIWMB within 90 days after the end of that financial reporting year. The guarantee shall terminate no less than 60 days after the date that the operator, and the CIWMB have received the notice of such failure or termination, as evidenced by the return receipts. The guarantor shall establish alternate coverage as specified in §22228 on behalf of the operator within 60 days after such notice, unless the operator has done so.

(f) The CIWMB may require updated financial statements at any time from a guarantor. If the CIWMB finds, on the basis of such reports or information from other sources, including but not limited to, credit reports and reports from other state agencies, that the guarantor no longer meets the financial means test requirements of §22246 or any requirements of §22247, the CIWMB shall notify the guarantor and operator of such finding by certified mail. The guarantor shall establish alternate coverage as specified in §22228 on behalf of the operator within 60 days after such notice, unless the operator has done so.


22248. CIWMB - Closure and/or Postclosure Maintenance and/or Reasonably Foreseeable Corrective Action Insurance. (new)

(a) The issuer of the insurance policy shall be an insurer that, at a minimum, is licensed by the California Department of Insurance to transact the business of insurance in the State of California as an admitted carrier.

(b) If coverage is not available as specified in (a), the operator may seek coverage from an insurer which, at a minimum, shall be eligible to provide insurance as an excess or surplus lines insurer in California.

(c) If coverage is obtained as described in (b), the insurance shall be transacted by and through a surplus lines broker currently licensed under the regulations of the California Department of Insurance [California Insurance Code (CIC), Division 1, Part 2, Chapter 6] and upon the terms and conditions prescribed by the California Department of Insurance.

(d) The CIWMB or its designee may object to the use of any insurer at anytime, whether before or after placement of coverage based on information obtained from, but not limited to, the Surplus Line Association of California, Best’s Insurance Reports, and/or the Non-Admitted Insurers Quarterly List.

(e) The closure or postclosure maintenance insurance or reasonably foreseeable corrective action policy shall guarantee that funds will be available to close the solid waste landfill whenever final closure occurs or to provide postclosure maintenance for the solid waste landfill whenever the postclosure maintenance period begins or provide for corrective action for the solid waste landfill if corrective action is deemed necessary, whichever is applicable. The policy shall also guarantee that once the policy is in effect, an insurer shall conduct closure or postclosure maintenance and corrective action, up to an amount equal to the face amount of the policy.

(f) The insurance policy shall be issued for a face amount at least equal to the most recently approved closure and/or postclosure maintenance and/or reasonably foreseeable corrective action cost estimate(s) whichever is applicable, unless the policy is being used in combination with another acceptable mechanism. The term “face
amount” means the total amount the insurer is obligated to pay under the policy. Actual payments by the insurer will not change the face amount, although the insurer’s future liability may be lowered by the amount of the payments.

(g) An operator, or any other person authorized to conduct closure or postclosure maintenance or corrective action, may receive reimbursements for closure or postclosure maintenance or corrective action expenditures, whichever is applicable. Requests for reimbursement will be granted by the insurer only if the remaining value of the policy is sufficient to cover the remaining costs of closure or postclosure maintenance or corrective action and if the expenditures have been reviewed and approved in writing by the CIWMB or its designee.

(h) Each policy shall contain a provision allowing assignment of the policy to a successor operator. Such assignment may be conditional upon consent of the insurer, provided that such consent is not unreasonably refused.

(i) The insurance policy must provide that the insurer may not cancel, terminate or fail to renew the policy except for failure to pay the premium. The automatic renewal of the policy must, at a minimum, provide the insured with the option of renewal at the face amount of the expiring policy. If there is a failure to pay the premium, the insurer may cancel the policy by sending notice of cancellation by certified mail to the owner and operator, and the 120 days in advance of cancellation. If the insurer cancels the policy, the owner or operator must obtain alternate financial assurance as specified in §22228.

(j) For insurance policies providing coverage for postclosure maintenance, commencing on the date that liability to make payments pursuant to the policy accrues, the insurer shall thereafter annually increase the face amount of the policy. Such increases must be equivalent to the face amount of the policy, less any payments made, multiplied by an amount equivalent to 85 percent of the most recent investment rate or of the equivalent coupon-issued yield announced by the U.S. Treasury for 26-week Treasury securities.

(k) The operator may cancel the insurance policy only if alternate financial assurance is substituted as specified in §22227, or if the operator is no longer required to demonstrate financial responsibility in accordance with the requirements of Subchapter 2 of this Chapter.

(l) Each closure and/or postclosure maintenance and/or reasonably foreseeable corrective action insurance policy shall be evidenced by a certificate of insurance established by using form CIWMB 106 (4/96), which is incorporated by reference. Each certificate of insurance shall contain the insurer’s warranty that the policy conforms in all respects with the requirements of this Subdivision, as applicable, and as such regulations were constituted on the date the policy is certified to on an annual basis. In addition, the insurer shall agree that any provision of the policy inconsistent with these regulations is amended to eliminate such inconsistency by submittal of the certification for closure and/or postclosure maintenance and/or reasonably foreseeable corrective action insurance.


22249. CIWMB - Local Government Financial Test.

(a) To pass the local government financial test, and to demonstrate financial responsibility for postclosure maintenance and/or corrective action costs, an operator or a guarantor shall be a local government agency and shall meet the criteria of sections (e), (f), (i) and (j) based on financial statements prepared in conformity with Generally Accepted Accounting Principles for governments and have its financial statements audited by an independent certified public accountant.

(b) A local government is not eligible to assure its obligations under section 22249 if it:

1. Is currently in default on any outstanding general obligation bonds, or

2. Has any outstanding general obligation bonds rated lower than Baa as issued by Moody’s or BBB as issued by Standard and Poor’s, or

3. Has operated at a deficit equal to five percent or more of total annual revenue in each of the past two fiscal years, or

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(4) Receives an adverse opinion, disclaimer of opinion, or other qualified opinion from the independent certified public accountant auditing its financial statement as required by section (a).

(c) The phrase "current postclosure maintenance cost estimates covered by the test" refers to the current postclosure maintenance cost estimate required by section (j)(1) to be shown in paragraphs 1 and 2 of the letter from the chief financial officer.

(d) The phrase "current corrective action cost estimates covered by the test" refers to the current corrective action cost estimate required by section (j)(1) to be shown in paragraphs 1 and 2 of the letter from the chief financial officer.

(e) The total amount of postclosure maintenance costs and corrective action costs which can be assured under this local government financial test is determined as follows:

(1) If the local government operator or guarantor does not assure other environmental obligations through a financial test, it may assure postclosure maintenance costs and/or corrective action costs that equal up to 43 percent of the local government's total annual revenue.

(2) If the local government operator or guarantor assures other environmental obligations through a financial test, including but not limited to those associated with underground injection control wells, petroleum underground storage tank facilities, PCB storage facilities, and hazardous waste treatment, storage, and disposal facilities, it must add those costs to the postclosure maintenance costs and/or corrective action costs it seeks to assure. The total that may be assured must not exceed 43 percent of the local government's or guarantor's total annual revenue.

(3) The operator or guarantor must obtain an alternate financial assurance instrument for those costs that exceed the limits set in (1) and (2).

(f) The operator or guarantor shall meet the criteria of either section (g) or (h) based on the operator's or guarantor's most recent audited annual financial statements prepared in conformity with Generally Accepted Accounting Principles for governments.

(g) The operator or guarantor shall satisfy each of the following financial ratios based on the operator's or guarantor's most recent audited annual financial statements prepared in conformity with Generally Accepted Accounting Principles for governments:

(1) Liquidity ratio: a ratio of cash plus marketable securities to total expenditures greater than or equal to 0.05; and

(2) Debt service ratio: a ratio of annual debt service to total expenditures less than or equal to 0.20; or

(h) An operator or guarantor with outstanding, rated, general obligation bonds that are not secured by insurance, a letter of credit, or other collateral or guarantee must have such bonds with current investment grade rating as follows:

(1) Aaa, Aa, A or Baa, as issued by Moody's on all such general obligation bonds; or

(2) AAA, AA, A, or BBB, as issued by Standard and Poor's on all such general obligation bonds.

(i) The operator or guarantor shall provide public notice of the local government's assured obligations by placing a reference to the postclosure maintenance costs and/or corrective action costs assured through the financial test into its next comprehensive annual financial report (CAFR). If timing does not permit the reference to be incorporated into the most recently issued CAFR or budget prior to the first year the financial test is used to assure local government solid waste facility obligations, the reference may instead be placed in the operating record until issuance of the next available CAFR. The operator shall certify that the reference to the postclosure maintenance costs and/or corrective action costs assured through the financial test is provided. The operator's certification shall be submitted with the chief financial officer letter as specified in section (i)(2).

(1) For postclosure maintenance costs, conformance with Government Accounting Standards Board (GASB) Statement 18 assures compliance with this public notice requirement.

(2) The following, including the GASB requirements, shall be disclosed:

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(k) The CIWMB may require updated financial statements at any time from the operator or guarantor. If the CIWMB finds that the operator or guarantor no longer meets the local government financial test requirements of sections (g) or (h), the operator shall obtain alternate coverage within 60 days after receiving the notification of such a finding.

(l) If, when preparing its annual update, an operator using the local government financial test fails to meet the requirements of the financial test under sections (g) or (h), the operator shall obtain alternate coverage within 210 days after the close of the financial reporting year.

(m) If the operator fails to obtain alternate coverage within the times specified in sections (k) or (l), the operator shall notify the CIWMB by certified mail within 10 business days of such failure.

(n) A local government financial test may be combined with another payment mechanism to assure the amount of required coverage specified in sections 2211 and 22221 of Subchapter 2.

NOTE: Authority cited: Sections 40502 and 43601.5, Public Resources Code. References: Sections 43500 through 43610.1, Public Resources Code, Part 258.74(f) and (h), Title 40 Code of Federal Regulations.

22249.5. CIWMB - Local Government Guarantee.

(a) The guarantor shall be a local government which meets the requirements of the Local Government Financial Test under section 22249 of this Article based on the guarantor's audited year-end financial statements.

(b) The guarantee shall be worded and completed as specified by form CIWMB 113(7/98), which is incorporated by reference.

(c) When the guarantee specifies coverage for postclosure maintenance costs, the terms shall also specify:

(1) If the operator fails to perform postclosure maintenance in accordance with the applicable approved postclosure maintenance plan when required to do so, the guarantor shall either:

(A) Perform, or pay a third party to perform, postclosure maintenance in accordance with the applicable approved postclosure maintenance plan; or

(B) Establish and fund a trust fund as specified in section 22240 of this Article, in the name of the operator in the amount of the applicable current postclosure maintenance cost estimate covered by the guarantee; and/or

(d) When the guarantee specifies coverage for corrective action costs, the terms shall also specify:

(1) If the operator fails to perform corrective action in accordance with the applicable approved corrective action plan when required to do so, the guarantor shall either:

(A) Perform, or pay a third party to perform, corrective action in accordance with the applicable approved corrective action plan; or

(B) Establish and fund a trust fund as specified in section 22240 of this Article, in the name of the operator in the amount of the applicable current corrective action cost estimate covered by the guarantee; and/or

(e) The guarantee will remain in force unless the guarantor fails to meet the requirements of sections 22249 and/or 22249.5 of this Article, or wishes to terminate the guarantee. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the operator and the CIWMB, as evidenced by return receipts.

(1) The guarantor shall send a notice of cancellation by certified mail to the operator, and the CIWMB, within 180 days after the end of that financial reporting year. The guarantee shall terminate no less than 120 days after the date that the operator and the CIWMB received the notice of cancellation, as evidenced by the return receipts.

(2) If the guarantee is cancelled, the operator shall establish alternate assurance as specified in section 22228 of Article 1 of this Subchapter within 60 days after such notice.

(3) If the operator fails to provide alternate financial assurance:
(A) The operator shall send notice of such failure by certified mail to the guarantor, and the CIWMB, within the same 60 day period; and

(B) The guarantor must provide alternate assurance as specified in section 22228 of Article 1 of this Subchapter within 60 days after the date of the operator's notice.

(f) The CIWMB may require updated financial statements at any time from a guarantor. If the CIWMB finds that the guarantor no longer meets the local government financial test or guarantee requirements of sections 22249 and/or 22249.5 of this Article, the CIWMB shall notify the guarantor and operator of such finding by certified mail. If the CIWMB notifies the guarantor and the operator that the guarantee is no longer acceptable, the operator and guarantor shall comply with section 22249.5 (e) (2) and (3) of this Article.

(g) Only a guarantee for payment, rather than performance of work, may be combined with another payment mechanism to assure the amount of required coverage specified in sections 22206, 22211, 22216, and/or 22221 of Subchapter 2.

NOTE: Authority cited: Sections 40502 and 43601.5, Public Resources Code. References: Sections 43500 through 43610.1, Public Resources Code, Part 258.74(f) and (h), Title 40 Code of Federal Regulations.

22250. CIWMB - Federal Certification. (T14:§18292)

(a) A federal entity which is responsible for closure or postclosure maintenance of one or more solid waste landfills located in California may, in lieu of using the other financial mechanisms provided in this Article, provide a Federal Certification for each solid waste landfill, in accordance with this section.

(b) Each Federal Certification shall include the following:

(1) A commitment by the federal entity to make a timely request for the funds needed to complete the closure and postclosure maintenance activities described in the most recently approved final closure and postclosure maintenance plans in accordance with Executive Order 12088 dated October 13, 1978 and OMB Circular A-106 dated December 31, 1974, which are incorporated by reference, or any pertinent amendments to those requirements;

(2) Copies of the initial closure and postclosure maintenance cost estimates and any amendments thereto, prepared pursuant to §21820 and §21840, respectively; and

(3) A commitment by the federal entity not to restructure the closure and postclosure funding in a manner that would interfere with timely completion of closure or postclosure maintenance activities.

(c) Should Congress fail to appropriate the necessary funding for closure and postclosure maintenance of a disposal facility, the federal entity shall advise the CIWMB within 90 days of such failure, and shall provide to the CIWMB, documentation of all measures it will undertake to ensure that closure and postclosure activities are completed in accordance with the most recently approved closure and postclosure maintenance plans.

(d) Nothing in this section shall be deemed to require any federal entity, or employees, agents, or representative thereof, to violate the federal Anti-Deficiency Act, 31 U.S.C. §1341.

(e) Each federal entity owning or operating a solid waste landfill in California on or after January 1, 1989, and choosing to provide assurance by using the Federal Certification, shall file the necessary documents with the CIWMB not later than 120 days after the effective date of these amendments or, for new disposal facilities, at the time of application for a solid waste facility permit.

(f) A federal entity may choose to act as a provider of financial assurance for closure or postclosure maintenance on behalf of private or other entities operating solid waste landfills, if either:

(1) The solid waste landfill is located on federal land; or

(2) The operator operates or manages the solid waste landfill pursuant to a contract with the federal entity or an applicable subcontract.

.22251. CIWMB - Liability Insurance. (T14:§18236)
   (a) The issuer of the insurance policy shall be an insurer that, at a minimum, is licensed by the California Department of Insurance to transact the business of insurance in the State of California as an admitted carrier.
   (b) If coverage is not available as specified in .(a), the operator may seek coverage by an insurer which, at a minimum, shall be eligible to provide insurance as an excess or surplus lines insurer in California.
   (c) If coverage is obtained as described in .(b), the insurance shall be transacted by and through a surplus line broker currently licensed under the regulations of the California Department of Insurance and upon the terms and conditions prescribed in the California Insurance Code (CIC), Division 1, Part 2, Chapter 6.
   (d) The CIWMB or its designee may object to the use of any insurer at anytime, whether before or after placement of coverage based on information obtained from, but not limited to, the Surplus Line Association of California, Best's Insurance Reports, and/or the Non-Admitted Insurers Quarterly List.
   (e) Each insurance policy shall be either:
      (1) Evidenced by a certificate of liability insurance established by using form CIWMB 107 (4/96), which is incorporated by reference; or
      (2) Amended and evidenced by a liability insurance endorsement established by using form CIWMB 108 (4/96), which is incorporated by reference.

.22252. CIWMB - Self-Insurance and Risk Management. (T14:§18237)
   (a) To use the self-insurance and risk management mechanism an operator shall:
      (1) Be a public entity;
      (2) Be self-insured;
      (3) Employ a risk manager;
      (4) Have an active safety and loss prevention program that seeks to minimize the frequency and magnitude of third party damages caused by accidental occurrences and other self-insured losses;
      (5) Have procedures for and a recent history of timely investigation and resolution of any claims for third party damages caused by accidental occurrences and other self-insured losses; and
      (6) Satisfy any other reasonable conditions that the CIWMB determines are needed to ensure that the assured amount of funds shall be available in a timely manner.
   (b) This coverage shall be demonstrated by using form CIWMB 109 (4/96), which is incorporated by reference.

.22253. CIWMB - Insurance and Environmental Fund. (T14:§18240)
   (a) To be eligible to use this mechanism to demonstrate financial responsibility for compensating third parties for bodily injury and property damage, the operator shall fulfill the requirements of sections (a) through (e) of this section no later than July 2, 1992.
   (b) The operator shall submit a signed certification to the CIWMB on form CIWMB 110 (4/96), which is incorporated by reference; and
(c) The operator shall submit certification of coverage to demonstrate the establishment and maintenance of comprehensive general liability insurance coverage with limits in at least the amounts specified in Article 3 of Subchapter 2 of this Chapter. This insurance must conform to the requirements of §22251(a - d) and/or §22252(a); and

(d) The operator shall demonstrate the establishment of an environmental liability fund, which shall be fully funded, as described before July 2, 1997. This means that the operator shall make the initial payment as described in (d)(3) by July 2, 1992 and subsequent payments as described in section (d)(4) on July 1st of the following years: 1993, 1994, 1995, 1996, and 1997.

(1) The environmental liability fund shall have a trustee that is authorized to act as a trustee and whose trust operations are regulated and examined by a federal or state agency.

(2) The environmental liability fund shall be established by using form CIWMB 111 (4/96), which is incorporated by reference.

(3) The funding of the environmental liability fund shall be initiated with a payment of $200,000 or a payment that is at least equal to the applicable aggregate liability coverage amount specified in Article 3 of Subchapter 2 of this Chapter, divided by 5, which is the maximum number of years in the pay-in period.

(4) On each anniversary date of July 1, the minimum payment shall be determined by this formula:

\[
\text{Minimum Payment} = \frac{AC - CV}{Y + 1}
\]

where AC is the aggregate coverage required, CV is the current value of the trust fund and Y is the number of years remaining in the pay-in period.

(5) The operator may accelerate payments into the environmental liability fund. However, the value of the environmental liability fund shall be maintained at no less than the value that the environmental fund would have, if payments were made as specified in (d)(3) and (d)(4).

(6) If the value of the environmental liability fund becomes greater than the total amount of the applicable aggregate liability coverage, the operator may request in writing that the CIWMB authorize the release of the excess funds. The CIWMB shall review the request within 90 days of receipt of the request. If any excess funds are verified, the CIWMB shall instruct the trustee to release the funds.

(e) The operator may substitute any alternate financial assurance mechanism(s), as identified in §22227, for the Insurance and Environmental Fund mechanism.


.22254. CIWMB - State Approved Mechanism. (T14:§17258.74)

(a) An operator may satisfy the requirements of this Chapter by obtaining any other mechanism that meets the following criteria, and that is approved by the CIWMB.

(1) The financial assurance mechanisms must ensure that the amount of funds assured is sufficient to cover the costs assured when needed;

(2) The financial assurance mechanisms must ensure that funds will be available in a timely fashion when needed;

(3) The financial assurance mechanism(s) must be obtained by the operator before the first waste is received at a new facility and before any other financial mechanism is cancelled at existing facilities. The financial
mechanism must be maintained until the operator is released from the financial assurance requirements under this Chapter.

(4) The financial assurance mechanisms must be legally valid, binding and enforceable under State and Federal law.


SUBCHAPTER 4. FINANCIAL ASSURANCES ENFORCEMENT PROCEDURES

ARTICLE 1. SOLID WASTE FACILITIES

.22270. Scope and Applicability.

All operators of disposal facilities shall be subject to the requirements of this article, except state and federal operators.


.22271. Definitions.

(a) “Degree of non-compliance” means the status of compliance of an operator with the financial assurance requirements. An operator is either: (1) partially out of compliance with the requirements (“Minor”); or (2) completely out of compliance with the requirements (“Major”).

(b) “Potential for harm” means the degree to which operator’s actions adversely affect the public health, safety and the environment. This potential is based on the anticipated closure date for a facility. If the anticipated closure date is:

(1) 2 years or less the potential for harm is “Major.”

(2) more than 2 years and up to 10 years, the potential for harm is “Moderate.”

(3) over 10 years the potential for harm is “Minor.”


.22272. Notice of Violation.

(a) The CIWMB shall send a written Notice of Violation to an operator violating the requirements of Articles 1, 2 and 3 of Subchapter 2 of this Chapter (commencing with section 22205).

(b) The CIWMB shall send a copy of the Notice of Violation to the respective enforcement agency.

(c) The Notice of Violation shall:

(1) describe the violation which CIWMB staff believe is occurring; and

(2) describe the consequences of continued failure to comply or respond.

(d) An operator shall submit a response to a Notice of Violation within 10 working days from receipt of the Notice of Violation.

(e) The CIWMB may consider all contacts with an operator as “good faith” efforts to comply with the regulations, and the CIWMB may extend the timeframe for an operator to respond and/or comply, as the CIWMB deems necessary.
22273. Issuance of Notice and Order and Stipulated Notice and Order.
   (a) If an operator fails to respond to the Notice of Violation within the specified timeframe, the CIWMB shall
draft and send a Notice and Order, as defined in Title 14, California Code of Regulations section 18304, to the
operator, and notify the local enforcement agency of the enforcement action.

   (b) An operator shall respond to the CIWMB with evidence of compliance, or request an alternate schedule for
compliance, within 10 working days from receipt of the Notice and Order.

   (c) If an operator responds to the Notice and Order by offering partial compliance immediately, and full
compliance over a period of time, which is acceptable to the CIWMB, the CIWMB may enter into a Stipulated
Notice and Order with the operator.

   (d) If an operator fails to conform with the compliance schedule within the specified timeframe as provided in
the Notice and Order or Stipulated Notice and Order, further enforcement action may be taken by the CIWMB, as
specified in the Notice and Order or Stipulated Notice and Order.

NOTE: Authority cited: Sections 40502, 43040 and 43601.5, Public Resources Code. References: Sections
43040, 43500 through 43610.1, Public Resources Code.

22274. Compliance Options.
   (a) The CIWMB may consider compliance options other than imposing penalties. The CIWMB may consider
options that include, but are not limited to:

   (1) Placing restrictions on current financial assurance mechanism(s) being used by the operator such as,
requiring more frequent reporting requirements.

   (2) Prohibiting use of current financial assurance mechanism(s) being used by the operator, and requiring the
operator to establish an alternate mechanism as prescribed in section 22228 of this Title.

NOTE: Authority cited: Section 40502, 43040 and 43601.5, Public Resources Code. References: Sections
43040, 43600 through 43610.1, Public Resources Code.
22275. Penalty Calculations.

(a) If the CIWMB chooses to impose a penalty, the daily penalty shall equal an amount determined by the gravity-based matrix, in Table 1., using the degree of non-compliance and the potential for harm as the deciding factors, added to the economic benefit an operator receives from noncompliance with the regulations.

<table>
<thead>
<tr>
<th>DEGREE OF NON-COMPLIANCE</th>
<th>MAJOR</th>
<th>MINOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$10,000</td>
<td>$7,999</td>
</tr>
<tr>
<td>MAJOR TO TO</td>
<td>$8,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>MODERATE TO TO</td>
<td>$4,999</td>
<td>$1,999</td>
</tr>
<tr>
<td></td>
<td>$2,000</td>
<td>$800</td>
</tr>
<tr>
<td></td>
<td>$799</td>
<td>$499</td>
</tr>
<tr>
<td>MINOR TO TO</td>
<td>$500</td>
<td>$0</td>
</tr>
</tbody>
</table>

Table 1.

(1) The economic benefit portion of a penalty, for lack of liability coverage, shall be based on a minimum annual premium for liability insurance, as identified by a CIWMB survey of the insurance industry. The premium is multiplied by the number of years an operator is out of compliance (rounded up to the next whole year if a partial year of noncompliance exists).

(2) The economic benefit portion of a penalty, for lack of coverage for closure and/or postclosure maintenance costs shall be based on the current cost of a letter of credit or bond, as identified by a CIWMB survey of the banking industry or insurance industry, respectively. The cost for a letter of credit or bond is multiplied by a prorata factor for the length of time of non-compliance.

(b) Determinations of penalty amounts may be modified by the CIWMB for one or more of the following reasons:

(1) Evidence that adequate coverage has been subsequently provided, such as bank statements, letter from county treasurer verifying balance of fund, certificate demonstrating adequate coverage, etc.
(2) Evidence of a payment schedule, if applicable, detailing the operator's good faith efforts has been subsequently provided, such as past deposits to the financial assurance mechanism, etc.

(3) An operator's good faith efforts to comply or lack of good faith.

(4) An operator's degree of willingness to comply.

(5) An operator's history of compliance.

(6) Other unique factors such as size of operation, threat to public health and safety and the environment.

c) Penalties shall be pursued by the CIWMB administratively or through superior court based on the following criteria.

(1) If the total initial civil penalty assessment is $15,000 or less, the CIWMB may pursue penalties administratively pursuant to Public Resources Code, section 45011.

(2) If the total initial civil penalty assessment exceeds $15,000, the CIWMB may pursue penalties through superior court, pursuant to Public Resources Code, section 45023.


22276. Processing and Collection of Civil Penalty.

Processing and collection of civil penalties shall be made by the CIWMB as provided in Public Resources Code, Division 30, Part 5, Article 3 (commencing with section 45010).


22277. Appeals Process.

Any aggrieved person may appeal a Notice and Order by the CIWMB, according to Public Resources Code, sections 45017 and 45030.


22278. Continued or Recurring Violations.

(a) If an operator pays an initial penalty but fails to correct the violation pursuant to Notice and Order, or has recurring violations within a three year period from the date of the preceding Notice of Violation:

(1) the CIWMB may re-initiate the enforcement process;

(2) the CIWMB may pursue action to revoke a permit, according to Public Resources Code section 44306, and/or pursue closure of the facility;

(3) the CIWMB may pursue both 1 and 2 above.

Chapter 7. Special Treatment, Storage, and Disposal Units
Subchapter 1. Mining Waste Management
Article 1. SWRCB - Mining Waste Management Regulations (C15: Article 7)

[Note: Regulations in this article were promulgated by the State Water Resources Control Board (SWRCB), are administered by the appropriate Regional Water Quality Control Board (RWQCB) through the issuance of waste discharge requirements (WDRs), and are applicable to the owner or operator of a waste management unit for the treatment, storage, or disposal of mining waste (Mining Unit).]

.22470. SWRCB - Applicability. (C15: §2570)

(a) General — This article applies to all discharges of mining wastes. No SWRCB-promulgated parts of this subdivision except those in this article, Article 1 of Chapter 1 (i.e., §20080 et seq.), and such provisions of the other articles of this subdivision as specifically are referenced in this article shall apply to discharges of “mining wastes” as that term is defined in §22480. Mining Units (including surface impoundments, waste piles, and tailings ponds) which receive WDRs after November 27, 1984, shall comply with the siting and construction standards in this article. Existing active and inactive Mining Units shall comply with the siting and construction requirements of this article as required by the RWQCB. Dischargers shall submit a report of waste discharge in compliance with Article 4, Subchapter 3, Chapter 4 of this subdivision (§21710 et seq.), and shall have WDRs which implement the appropriate provisions of this article unless requirements are waived by the RWQCB. Requirements for new and existing Mining Units are summarized on Table 1.1 of this article. The RWQCB can impose more stringent requirements to accommodate regional and site specific conditions.

(b) Dry Unit Liner/LCRS Exemption — A RWQCB can exempt a mining waste pile from the liners and leachate collection and removal systems required in this article if the discharger clearly demonstrates to the RWQCB that leachate will not form in or escape from that Mining Unit. The RWQCB can require extensive monitoring procedures in lieu of certain containment features. Contingency plans shall be developed and shall be implemented if monitoring indicates that the disposal procedures are inadequate.

(c) Exemptions Based On No/Little/Poor G.W. — The RWQCB can exempt a Group A or B (see §22480 of this article) Mining Unit from certain provisions of this article if a comprehensive hydrogeologic investigation demonstrates that:

1. there are only very minor amounts of groundwater underlying the area; or
2. the discharge is in compliance with the applicable water quality control plan; and
3. either natural conditions or containment structures will prevent lateral hydraulic interconnection with natural geologic materials containing ground water suitable for agricultural, domestic, or municipal beneficial uses. There is no detectable vertical hydraulic interconnection between the natural geologic materials underlying the Unit and natural geologic materials containing such ground water.

If the above demonstration is acceptable to the RWQCB, the discharger can be exempted from requirements for liners and leachate collection and removal systems (see §22490 of this article). However, the discharger shall comply with the requirements of this article relative to siting, precipitation and drainage controls, and surface water quality monitoring. Closure and post closure maintenance periods shall be designed to protect surface water quality. Ground water monitoring, and unsaturated zone monitoring as feasible, shall be conducted during the active life, closure, and post closure maintenance period to verify that the Unit is not affecting ground water suitable for agricultural, domestic, or municipal beneficial uses.


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22480. SWRCB - Groups of Mining Waste. (C15: §2571)
(a) Definition — Mining waste is waste from the mining and processing of ores and mineral commodities. Mining waste includes:

(1) overburden;

(2) natural geologic material which have been removed or relocated but have not been processed (waste rock); and

(3) the solid residues, sludges, and liquids from the processing of ores and mineral commodities.

(b) Waste Group — Id classificationCMining wastes shall be classified as Group A, Group B, or Group C mining wastes based on an assessment of the potential risk of water quality degradation posed by each waste. In setting requirements for each mining waste discharge under this article, the RWQCB shall assign the waste to Group A, Group B, or Group C according to the following criteria:

(1) Group A — mining wastes of Group A are wastes that must be managed as hazardous waste pursuant to Chapter 11 of Division 4.5, of Title 22 of this code, provided the RWQCB finds that such mining wastes pose a significant threat to water quality;

(2) Group B — mining waste of Group B are either:

(A) mining wastes that consist of or contain hazardous wastes, that qualify for a variance under Chapter 11 of Division 4.5, of Title 22 of this code, provided that the RWQCB finds that such mining wastes pose a low risk to water quality; or

(B) mining wastes that consist of or contain nonhazardous soluble pollutants of concentrations which exceed water quality objectives for, or could cause, degradation of waters of the state; or

(3) Group C — mining wastes from Group C are wastes from which any discharge would be in compliance with the applicable water quality control plan, including water quality objectives other than turbidity.

(c) Classification Considerations — In reaching decisions regarding classification of a mining waste as a Group B or Group C waste, the RWQCB can consider the following factors:

(1) whether the waste contains hazardous constituents only at low concentrations;

(2) whether the waste has no or low acid generating potential; and

(3) whether, because of intrinsic properties, the waste is readily containable by less stringent measures.

(d) Treatment — Mining waste shall be treated or neutralized whenever feasible to minimize the threat to water quality and minimize the need to install waste containment structures.


22490. SWRCB - Mining Unit Siting and Construction Standards. (C15: §2572)
(a) Proximity to Faults — New Mining Units:

(1) for Group A and B wastes, shall not be located on Holocene faults. Units for Group C wastes may be located on Holocene faults if displacement will not allow escape of wastes or cause irreparable damage to containment structures;

(2) shall be outside of areas of rapid geologic change. Exemptions may be allowed by the RWQCB if containment structures are designed and constructed to preclude failure.

(b) Flooding — All Mining Units shall be protected from flooding as shown on Table 1.2 of this article.

(c) Construction & Discharge Standards — General construction standards are given on Table 1.3 of this article. Procedures for determining appropriate methods for discharges of Groups A and B mining wastes are outlined in Figures 1.1 and 1.2 of this article.
(d) Registered Professionals — Containment structures shall be designed by a registered civil engineer, and construction shall be supervised and certified by a registered civil engineer or a certified engineering geologist.

(e) General Containment Structure Criteria — Dischargers shall comply with general criteria for containment structures in §20320.

(f) Liners.
(1) FMLs — Synthetic liners (40 mil minimum thickness) can be used for waste piles where the discharger can demonstrate that the liner will function adequately during the active life of the waste pile and provided that the waste pile is closed in accordance with §21410.

(2) Relative Permeability — Permeabilities shall be relative to the fluids, including waste or leachate, to be contained.

(3) Clay Liners — Clay liners shall be of a minimum of two feet thick and shall be installed at relative compaction of at least 90 percent.

(4) Replaceable Clay-Liners — Single clay liners may be used for Group B surface impoundments if replaced as specified in §20330(c).

(5) Contingency Plan — If the RWQCB exempts a discharger from liner requirements for a waste pile, a contingency plan for alternative waste containment shall be developed. The plan shall be implemented if there is failure of the waste pile containment system.

(6) Dischargers shall comply with the liner criteria given in §20330(a & d).

(g) Leachate Collection and Removal Systems (LCRSes) for Group A and B Wastes.
(1) All LCRSes shall be of the blanket type.

(2) Dischargers shall comply with leachate collection and removal system (LCRS) requirements given in §20340(b – e).

(h) Precipitation and Drainage Controls.
(1) Design Storm — Diversion and drainage facilities shall be designed and constructed to accommodate the anticipated volume of precipitation and peak flows from surface runoff as follows:

(A) Group A — one 25 year, 24 hour storm;

(B) Group B — one 10 year, 24 hour storm; and

(C) Group C — one 10 year, 24 hour storm.

(2) Excess Runoff — Precipitation on Group A and B waste piles that is not diverted by containment structures shall be collected and managed through the LCRS. The RWQCB can make exemptions to this requirement if the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality objectives.

(3) Precipitation/Drainage Controls — Dischargers shall comply with precipitation and drainage control requirements given in §20365(d & e).

(i) Incorporated Impoundment Requirements — Dischargers shall comply with special requirements for surface impoundments given in §20375. Nevertheless, for Mining Units, dischargers shall use the precipitation conditions in (b)(1).


.22500. SWRCB - Water Quality Monitoring for Mining Units. (C15: §2573)

(a) General — New and existing Group A and B Mining Units shall comply with the monitoring provisions contained in §20385 through §20430.
(b) Monitoring Mandatory — If a waste pile containing Group A or B mining wastes is granted exemption from construction requirements pursuant to §22470(b), monitoring of the waste moisture content shall be required. NOTE: Authority cited: Section 1058, Water Code. Reference: Sections 13172, 13226, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

22510. SWRCB - Closure and Post Closure Maintenance of Mining Units. (C15: §2574)

(a) Closure Performance Standard — New and existing Mining Units shall be closed so that they no longer pose a threat to water quality. No post closure land uses shall be permitted that might impair the integrity of containment structures.

(b) Plan — Mining Units shall be closed according to an approved closure and post closure maintenance plan which implements this section and provides for continued compliance with the applicable standards in this article for waste containment, precipitation and drainage controls, and monitoring throughout closure and the post closure maintenance period.

(c) Reclamation — The RWQCB shall issue WDRs which incorporate the relevant provisions of an approved mining and reclamation plan (see California Surface Mining and Reclamation Act, Public Resources Code, Section 2770, et seq.), prescribe additional conditions as necessary to prevent water quality degradation, and ensure that there will be no significant increase in the concentration of indicator parameters or waste constituents in ground or surface water, unless requirements are waived.

(d) Oversight & Monuments — Dischargers shall comply with the closure requirements given in §20950(b & d).

(e) Inactive Units — Containment structures at inactive Mining Units shall be subject to the same standards as apply to an active Mining Unit under this article.

(f) Closure and Post-Closure Funding — The discharger shall provide for adequate funding to pay for the costs of closure and post closure maintenance as required by this article. The discharger shall provide assurance of financial responsibility, acceptable to the RWQCB, pursuant to Chapter 6 of this title. The RWQCB shall periodically review financial assurances and shall modify them as necessary.

(g) Alternate Financial Assurance — If a lead agency acting under the authority of §2774(a) of the Public Resources Code requires assurances of financial responsibility, these assurances can be used to fulfill all comparable requirements under .(f), provided that:

(1) the RWQCB approves the assurance; and
(2) the RWQCB is named as alternate payee.

(h) Ending Post-Closure — The post closure maintenance period shall end when the RWQCB determines that water quality aspects of reclamation are complete and waste no longer poses a threat to water quality.

(i) Vegetation — Vegetation for closed Mining Units shall not impair the integrity of containment features. Irrigation of vegetation shall be managed to assure that it does not cause nor increase the production of leachate.

(j) Waste Pile Closure Standards — New and existing Group A and B waste piles shall be closed in accordance with the provisions of §21090(a - c).

(k) Surface Impoundment Closure Standards — New and existing Group A and B surface impoundments shall be closed in accordance with the provisions of paragraphs (a) and (b)(1) of §21400. A surface impoundment can be closed in place if provided with a cover as in §21090(a) and if the liner (or, in the case of a double liner system, the outer liner) is clay.

(l) Tailings Pond Closure Standards — New and existing Group A and B tailings ponds shall be closed in accordance with the provisions of §21090(a - c) and §21400(a).

(m) Erosion & Sedimentation Protection — New and existing Group C Mining Units shall be closed in a manner that will minimize erosion and the threat of water quality degradation from sedimentation.
Table 1.1. Summary of Requirements for New and Existing Mining Units

<table>
<thead>
<tr>
<th>Type of Requirement</th>
<th>New Units</th>
<th>Existing Units</th>
<th>Exclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siting</td>
<td>(1) Not on Holocene faults; (2) Outside of areas of rapid geologic change; (3) Peak streamflow protection as in Table 1.2.</td>
<td>Peak streamflow protection as in Table 1.2, as required by RWQCBs</td>
<td>New Units may be sited in areas of rapid geologic change if containment structures designed and constructed to preclude failure.</td>
</tr>
<tr>
<td>Construction</td>
<td>(1) Liners or maximum natural permeability as in Table 1.2; (2) Leachate collection and removal system as in Table 1.3; (3) Precipitation and drainage controls.</td>
<td>Precipitation and drainage controls.</td>
<td>(1) No liners or leachate collection and removal systems required for Group C Units. (2) New waste plans may be exempted from liners and leachate collection and removal systems if it can be demonstrated that leachate will not form or escape and contingency plans required, and additional monitoring may be required.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>(1) Ground water and surface water; (2) Unsatuated zone monitoring as feasible.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Closure and Post-Closure Maintenance</td>
<td>Closed and maintained in accordance with §22510.</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 1.2 Floodplain Siting Criteria

<table>
<thead>
<tr>
<th>Waste Group</th>
<th>Waste Management Unit</th>
<th>Existing Units(^1)</th>
<th>New Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Waste Pile/Surface Impoundment/Tailings Pond</td>
<td>Protect from 100-year peak streamflow</td>
<td>Outside 100-year floodplain</td>
</tr>
<tr>
<td>B</td>
<td>Waste Pile/Surface Impoundment/Tailings Pond</td>
<td>Protect from 100-year peak streamflow</td>
<td>Protect from 100-year peak streamflow</td>
</tr>
<tr>
<td>C</td>
<td>Waste Pile/Surface Impoundment/Tailings Pond</td>
<td>Retrofit as needed to protect surface water quality</td>
<td>Preclude increases sediment in surface water(^3)</td>
</tr>
</tbody>
</table>

1 As required by the RWQCB pursuant §22470(a).

2 Mining wastes shall not be placed in perennial, intermittent, or ephemeral stream channels unless provision is made to divert runoff around the waste in a non-erosive manner. Wastes shall not be placed where they can be eroded by streams or where they can cause accelerated streambank erosion. Waste generated during seasonal mining operations may be exempted from these requirements provided that increased sediment in surface water is precluded.
Table 1.3 Natural and Artificial Containment Features for Mining Units

<table>
<thead>
<tr>
<th>Waste Group</th>
<th>Waste Management Unit</th>
<th>Geologic Setting</th>
<th>Liner(s) Hydr. Cond. Values (Units: cm/sec)</th>
<th>Leachate Collection and Removal System</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Waste Pile</td>
<td>per §2531(b)(1) of Title 23, OR single clay liner: 1 (1\times10^{-9}) cm/sec</td>
<td>double liner, both (1\times10^{-7}) outer; clay liner: clay or synthetic</td>
<td>required</td>
</tr>
<tr>
<td></td>
<td>Surface Impoundment or Tailings Pond</td>
<td>not applicable</td>
<td></td>
<td>required</td>
</tr>
<tr>
<td>B</td>
<td>Waste Pile</td>
<td>per §20250(b)(1) OR single clay liner</td>
<td>(1\times10^{-4})</td>
<td>required</td>
</tr>
<tr>
<td></td>
<td>Surface Impoundment or Tailings Pond</td>
<td>not applicable</td>
<td>double liner, both (1\times10^{-4}) outer; clay or natural permeability; inner: clay or synthetic OR single replaceable clay liner</td>
<td>required</td>
</tr>
<tr>
<td>C</td>
<td>Waste Pile, Surface Impoundment, or Tailings Pond</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
</tr>
</tbody>
</table>

1. Synthetic liner may be used for short-term containment [see §22490(f)(1)].
2. Liner and leachate collection and removal system for tailings pond must be able to withstand the ultimate weight of wastes.
3. Permeability of \(1\times10^{-6}\) cm/sec or natural geologic materials may replace outer liner of double liner system.
4. Single clay liner (\(1\times10^{-4}\) cm/sec) for surface impoundment, to be removed before last 25 percent (minimum 1 foot thickness) of liner is penetrated by fluid, including waste and leachate.
Figure 1.2

DISPOSAL ALTERNATIVES FOR GROUP B WASTES

NOTE: all figures are shown at the end of this file.
(2) Existing facilities that were in operation on-or-before November 27, 1984, and that are protected against 100-year peak stream flows must continue to provide such protection. Facilities, or portions thereof, which begin operating after November 27, 1984, shall be protected against 100-year peak stream flows.

(3) The determination of peak stream flows shall be from data provided by a recognized federal, state, local, or other agency.

(d) Retention Pond Design — Retention ponds shall be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or artificial materials of equivalent impermeability.

(e) Discharge To Disposal/Use Fields — The RWQCB shall allow the discharge of facility wastewater and of collected precipitation and drainage waters to use or disposal fields only if such discharge is in accordance with §22563. Absent an NPDES permit for discharge to surface waters, the only other allowable discharge is to wastewater treatment facilities approved by the RWQCB.


22563. SWRCB - Use or Disposal Field Management. (Ch-15: §22563)

(a) Reasonable Soil Amendment Rate — Application of manure and wastewater to disposal fields or crop lands shall be at rates which are reasonable for the crop, soil, climate, special local situations, management system, and type of manure.

(b) Run-Off & Percolation — Discharges of facility wastewater to disposal fields shall not result in surface runoff from disposal fields and shall be managed to minimize percolation to groundwater.


22564. SWRCB - Management of Manured Areas. (Ch-15: §22564)

Manured areas shall be managed to minimize infiltration of water into underlying soils.


22565. SWRCB - Monitoring. (Ch-15: §22565)

The RWQCB can require confined animal facility operations to undertake a monitoring program as a condition to the issuance or waiver of WDRs.


Subchapter 3. Composting Facilities [Reserved by CIWMB]

Subchapter 4. Waste Tire Facilities [Reserved by CIWMB]

Subchapter 5. Transfer and Processing Stations [Reserved by CIWMB]
Figure 1.1
DISPOSAL ALTERNATIVES FOR GROUP A WASTES

GROUP A WASTE

TREAT OR NEUTRALIZE WASTE?

YES

REEvaluate WATER QUALITY THREAT

CHANGED

NO CHANGE

REASSIGN TO LOWER GROUP

NO

QUALITY OF UNDERLYING WATER?

"POOR" OR ONLY MINOR AMOUNTS OF WATER

GOOD

CONNECTED WITH OTHER "GOOD" WATERS

NO

STOP

YES

NO-WILL NOT INCREASE GROUND WATER VALUES

OF INDICATOR PARAMETERS AND WASTE CONSTITUENTS ABOVE BACKGROUND

SOlUBLE WASTE?

YES

TYPE OF FACILITY?

SURFACE IMPOUNDMENT OR TAILINGS POND

WASTE PILE

SHORT OR LONG-TERM LOCATION (PER 22560(R))

SHORT

NATURAL PERMEABILITY <1X10⁻⁸ CM/SEC

NO

CLAY OR SYNTHETIC LINER <1X10⁻⁷ CM/SEC

YES

NATURAL PERMEABILITY >1X10⁻⁸ CM/SEC

LONG

STOP

LEACHATE COLLECTION AND REMOVAL SYSTEM BETWEEN LINERS

STOP

DOUBLE LINER, INNER-CLAY OR SYNTHETIC SYNTHETIC <1X10⁻⁷ CM/SEC OUTER-CLAY <1X10⁻⁷ CM/SEC

1 CONTAINMENT FEATURES TO PROTECT SURFACE WATER ARE REQUIRED.

2 SEE SUBSECTION 22560(C) OF THIS ARTICLE.
**Figure 1.2**

**DISPOSAL ALTERNATIVES FOR GROUP B WASTES**

1. Containment features to protect surface water are required.
2. Surface impoundments only.
3. See subsection 22470(c) of this article.
FIGURE 4.1

CLAY & SYNTHETIC LINER REQUIREMENTS FOR
CLASS I LANDFILLS, WASTE PILES, & SURFACE IMPOUNDMENTS

LANDFILL

SWITCHING APPROACH FOR WASTE CONTAINMENT
NECESSARY TO COMPLY WITH HAZWOPER (42 CFR PARTS 284.221, 284.261 AND 284.301)
COMBINATION NEEDED TO COMPLY WITH REQUIREMENTS OF THIS SUBCHAPTER

CLAY LINER

SYNTHETIC LINER

SYNTHETIC LINER

SYNTHETIC LINER

WASTE PILE

CLAY LINER

SYNTHETIC LINER

SYNTHETIC LINER

SYNTHETIC LINER

CLAY LINER

OR

SYNTHETIC LINER

OR

CLAY LINER

OR

CLAY LINER

OR

CLAY LINER

ACCEPTABILITY OF SYNTHETIC LINER DEPENDS ON
(1) NATURE OF WASTE
(2) DURATION OF OPERATION
(3) REMOVAL OF LINER AT END OF OPERATION

LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE

SURFACE IMPOUNDMENT

SYNTHETIC OR CLAY LINER

CLAY LINER

CLAY LINER

CLAY LINER

LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE
LIGNER AND WASTE ARE TO BE REMOVED AT CLOSURE

LEGEND

LEACHATE COLLECTION AND REMOVAL SYSTEM
SYNTHETIC LINER
CLAY LINER
NATURAL GEOLoGIC MATERIALS
HEAVY PATTERN SIGNIFIED PERMEABILITy = 1 X 10-7 CM SEc OR LESS

* ALL CLAY LINER PERMEABILITIES ARE 1 X 10-7 CM SEc OR LESS
** MAY BE EXEMPTED IF IT CAN BE DEMONSTRATED THAT ALTERNATE DESIGN AND OPERATING PRACTICES, TOGETHER WITH LOCATION CHARACTERISTICS, WILL PREVENT THE MIGRATION OF HAZARDOUS CONSTITUENTS INTO SOIL, GROUNDWATER OR SURFACE WATER AT ANY FUTURE TIME (PURSUANT TO 40 CFR PARTS 284.301(b), and 284.221(b))
Title 14. California Code of Regulations
Chapter 3. Guidelines for Implementation of the California Environmental Quality Act

Article 1. General
Sections 15000 to 15007

15000. Authority

The regulations contained in this chapter are prescribed by the Secretary for Resources to be followed by all state and local agencies in California in the implementation of the California Environmental Quality Act. These Guidelines have been developed by the Office of Planning and Research for adoption by the Secretary for Resources in accordance with Section 21083. Additional information may be obtained by writing:

Secretary for Resources
1416 Ninth Street, Room 1311
Sacramento, CA 95814

These Guidelines are binding on all public agencies in California.


Discussion: This section specifies that these regulations are binding on all state and local agencies when implementing CEQA. The section also provides the address where people can write to obtain additional information about the Guidelines.

Section 21082 of CEQA and the court decision cited in the note show that agencies must comply with the Guidelines. The regulations are labeled "Guidelines" because they contain many advisory and permissive interpretations in addition to mandatory requirements. When the Legislature called for the Guidelines to be adopted, it seemed to envision this guidance role in addition to a purely regulatory role.

15001. Short Title

These Guidelines may be cited as the "State CEQA Guidelines." Existing references to the "State EIR Guidelines" shall be construed to be references to the State CEQA Guidelines.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21083 and 21087, Public Resources Code.

15002. General Concepts

(a) Basic Purposes of CEQA. The basic purposes of CEQA are to:

(1) Inform governmental decision-makers and the public about the potential, significant environmental effects of proposed activities.

(2) Identify the ways that environmental damage can be avoided or significantly reduced.

(3) Prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible.

(4) Disclose to the public the reasons why a governmental agency approved the project in the manner the agency chose if significant environmental effects are involved.

(b) Governmental Action. CEQA applies to governmental action. This action may involve:

(1) Activities directly undertaken by a governmental agency,

(2) Activities financed in whole or in part by a governmental agency, or

(3) Private activities which require approval from a governmental agency.

(c) Private Action. Private action is not subject to CEQA unless the action involves governmental participation, financing, or approval.

(d) Project. A "project" is an activity subject to CEQA. The term "project" has been interpreted to mean far more than the ordinary dictionary definition of the term. (See: Section 15378.)

(e) Time for Compliance. A governmental agency is required to comply with CEQA procedures when the agency proposes to carry out or approve the activity. (See: Section 15004.)

(f) Environmental Impact Reports and Negative Declarations. An Environmental Impact Report (EIR) is the public document used by the governmental agency to analyze the significant environmental effects of a proposed project, to identify alternatives, and to disclose possible ways to reduce or avoid the possible environmental damage.

(1) An EIR is prepared when the public agency finds substantial evidence that the project may have a significant effect on the environment. (See: Section 15064(a)(1).)

(2) When the agency finds that there is no substantial evidence that a project may have a significant environmental effect, the agency will prepare a "Negative Declaration" instead of an EIR. (See: Section 15070.)

(g) Significant Effect on the Environment. A significant effect on the environment is defined as a substantial adverse change in the physical conditions which exist in the area affected by the proposed project. (See: Section 15382.) Further, when an EIR identifies a significant effect, the government agency approving the project must make findings on whether the adverse environmental effects have been substantially reduced or if not, why not. (See: Section 15091.)

(h) Methods for Protecting the Environment. CEQA requires more than merely preparing environmental documents. The EIR by itself does not control the way in which a project can be built or carried out. Rather, when an EIR shows that a project would cause substantial adverse changes in the environment, the governmental agency must respond to the information by one or more of the following methods:

(1) Changing a proposed project

(2) Imposing conditions on the approval of the project;

(3) Adopting plans or ordinances to control a broader class of projects to avoid the adverse changes;
(4) Choosing an alternative way of meeting the same need;

(5) Disapproving the project;

(6) Finding that changing or altering the project is not feasible;

(7) Finding that the unavoidable significant environmental damage is acceptable as provided in Section 15093.

(i) Discretionary Action. CEQA applies in situations where a governmental agency may use its judgment in deciding whether and how to carry out or approve a project. A project subject to such judgmental controls is called a "discretionary project." (See: Section 15357.)

(1) Where the law requires a governmental agency to act on a project in a set way without allowing the agency to use its own judgment, the project is called "ministerial," and CEQA does not apply. (See: Section 15369.)

(2) Whether an agency has discretionary or ministerial controls over a project depends on the authority granted by the law providing the controls over the activity. Similar projects may be subject to discretionary controls in one city or county and only ministerial controls in another. (See: Section 15268.)

(j) Public Involvement. Under CEQA, an agency must solicit and respond to comments from the public and other agencies concerned with the project. (See: Sections 15073, 15086, 15087, and 15088.)

(k) Three Step Process. An agency will normally take up to three separate steps in deciding which document to prepare for a project subject to CEQA.

(1) In the first step the Lead Agency examines the project to determine whether the project is subject to CEQA at all. If the project is exempt, the process does not need to proceed any further. The agency may prepare a Notice of Exemption. (See: Sections 15061 and 15062.)

(2) If the project is not exempt, the Lead Agency takes the second step and conducts an Initial Study (Section 15063) to determine whether the project may have a significant effect on the environment. If the Initial Study shows that there is no substantial evidence that the project may have a significant effect, the Lead Agency prepares a Negative Declaration. (See: Sections 15070 et seq.)

(3) If the Initial Study shows that the project may have a significant effect, the Lead Agency takes the third step and prepares an EIR. (See: Sections 15080 et seq.)

(l) Certified Equivalent Programs. A number of environmental regulatory programs have been certified by the Secretary of the Resources Agency as involving essentially the same consideration of environmental issues as is provided by use of EIRs and Negative Declarations. Certified programs are exempt from preparing EIRs and Negative Declarations but use other documents instead. Certified programs are discussed in Article 17 and are listed in Section 15251.

(m) This section is intended to present the general concepts of CEQA in a simplified and introductory manner. If there are any conflicts between the short statement of a concept in this section and the provisions of other sections of these Guidelines, the other sections shall prevail.


Discussion: This section is intended to serve as a short introduction to CEQA for people who are unfamiliar with the Act. This section provides a simple outline of the basic concepts, purposes, documents, and processes used in CEQA.

15003. Policies

In addition to the policies declared by the Legislature concerning environmental protection and administration of CEQA in Sections 21000, 21001, 21002, and 21002.1 of the Public Resources Code, the courts of this state have declared the following policies to be implicit in CEQA:

(a) The EIR requirement is the heart of CEQA. (*County of Inyo v. Yorty*, 32 Cal. App. 3d 795.)

(b) The EIR serves not only to protect the environment but also to demonstrate to the public that it is being protected. (*County of Inyo v. Yorty*, 32 Cal. App. 3d 795.)

(c) The EIR is to inform other governmental agencies and the public generally of the environmental impact of a proposed project. (*No Oil, Inc. v. City of Los Angeles*, 13 Cal. 3d 68.)

(d) The EIR is to demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action. (*People ex rel. Department of Public Works v. Bostock*, 47 Cal. App. 3d 495.)

(e) The EIR process will enable the public to determine the environmental and economic values of their elected and appointed officials thus allowing for appropriate action come election day should a majority of the voters disagree. (*People v. County of Kern*, 39 Cal. App. 3d 830.)

(f) CEQA was intended to be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language. (*Friends of Mammoth v. Board of Supervisors*, 8 Cal. 3d 247.)

(g) The purpose of CEQA is not to generate paper, but to compel government at all levels to make decisions with environmental consequences in mind. (*Bozum v. LAFCO* (1975) 13 Cal.3d 263)

(h) The lead agency must consider the whole of an action, not simply its constituent parts, when determining whether it will have a significant environmental effect. (*Citizens Assoc. For Sensible Development of Bishop Area v. County of Inyo* (1985) 172 Cal.App.3d 151)

(i) CEQA does not require technical perfection in an EIR, but rather adequacy, completeness, and a good-faith effort at full disclosure. A court does not pass upon the correctness of an EIR's environmental conclusions, but only determines if the EIR is sufficient as an informational document. (*Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692)

(j) CEQA requires that decisions be informed and balanced. It must not be subverted into an instrument for the oppression and delay of social, economic, or recreational development or advancement. (*Laurel Heights Improvement Assoc. v. Regents of U.C.* (1993) 6 Cal.4th 1112 and *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553)

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21000-21177, Public Resources Code.

Discussion: This section highlights court cases that illustrate several essential principles in the application of CEQA. Each of these court opinions has been cited in numerous subsequent holdings. This section cannot reiterate all CEQA principles and should be read in conjunction with the entirety of the statute and Guidelines.

15004. Time of Preparation

(a) Before granting any approval of a project subject to CEQA, every Lead Agency or Responsible Agency shall consider a final EIR or Negative Declaration or another document authorized by these Guidelines to be used in the place of an EIR or Negative Declaration. (See: The definition of “approval” in Section 15352.)

(b) Choosing the precise time for CEQA compliance involves a balancing of competing factors. EIRs and negative declarations should be prepared as early as feasible in the planning process to enable environmental considerations to influence project program and design and yet late enough to provide

http://ceres.ca.gov/topic/env_law/ceqa/guidelines/art1.htm
meaningful information for environmental assessment.

(1) With public projects, at the earliest feasible time, project sponsors shall incorporate environmental considerations into project conceptualization, design, and planning. CEQA compliance should be completed prior to acquisition of a site for a public project.

(2) To implement the above principles, public agencies shall not undertake actions concerning the proposed public project that would have a significant adverse effect or limit the choice of alternatives or mitigation measures, before completion of CEQA compliance. For example, agencies shall not:

(A) Formally make a decision to proceed with the use of a site for facilities which would require CEQA review, regardless of whether the agency has made any final purchase of the site for these facilities, except that agencies may designate a preferred site for CEQA review and may enter into land acquisition agreements when the agency has conditioned the agency's future use of the site on CEQA compliance.

(B) Otherwise take any action which gives impetus to a planned or foreseeable project in a manner that forecloses alternatives or mitigation measures that would ordinarily be part of CEQA review of that public project.

(3) With private projects, the lead agency shall encourage the project proponent to incorporate environmental considerations into project conceptualization, design, and planning at the earliest feasible time.

(c) The environmental document preparation and review should be coordinated in a timely fashion with the existing planning, review, and project approval processes being used by each public agency. These procedures, to the maximum extent feasible, are to run concurrently, not consecutively. When the lead agency is a state agency, the environmental document shall be included as part of the regular project report if such a report is used in its existing review and budgetary process.


Discussion: This section codifies the requirement that EIRs and Negative Declarations be prepared before an agency makes a decision on the project and early enough to help influence the project's plans or design. For EIRs and Negative Declarations to be effective in serving the purposes of CEQA, the preparation of these documents must be coordinated with the planning, review, and approval processes as described in subsection (c). Early preparation is necessary for the legal validity of the process and for the usefulness of the documents. Early preparation enables agencies to make revisions in projects to reduce or avoid adverse environmental effects before the agency has become so committed to a particular approach that it can make changes only with difficulty.

The 1998 amendment clarifies that public agencies must consider the significant effects of a project before taking actions which may limit their choice of potential project alternatives and mitigation measures. This section also provides examples of how far the agency may proceed in its decision making prior to initiating the CEQA process.

15005. Terminology

The following words are used to indicate whether a particular subject in the Guidelines is mandatory, advisory, or permissive:

(a) "Must" or "shall" identifies a mandatory element which all public agencies are required to follow.

(b) "Should" identifies guidance provided by the Secretary for Resources based on policy considerations contained in CEQA, in the legislative history of the statute, or in federal court decisions which California courts can be expected to follow. Public agencies are advised to follow this guidance in the absence of compelling, countervailing considerations.
(c) "May" identifies a permissive element which is left fully to the discretion of the public agencies involved.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21082 and 21083, Public Resources Code.

Discussion: This section explains the terminology used in the Guidelines. The Guidelines contain sections that are clearly mandated, others that are strongly advisory, and still others that are permissive.

The advisory elements are an essential part of the Guidelines. Due to the requirement for state agencies to reimburse local government for any mandates contained in the state regulations, the Guidelines have avoided clear mandates except where they have been required by the CEQA statutes or state court decisions. Nevertheless, as a result of the legislative history of CEQA as interpreted by court decisions such as Friends of Mammoth v. Board of Supervisors, 8 Cal. 3d 247, there are many requirements for the Environmental Impact Statement process under the National Environmental Policy Act that the state courts are likely to apply under CEQA. The use of the term "should" identifies many of these requirements in federal case law which state courts have not yet followed. This language advises individual agencies to follow the provision in the Guidelines unless the agency has a compelling reason to take another approach. This advice helps to implement the preventive law function of the State CEQA Guidelines.

The permissive language serves two functions. First, the language identifies elements made permissive by the statute. Second, the language identifies interpretations where the Guidelines provide that certain activities or short cuts are authorized ways to administer the process. The interpretations are intended to provide certainty, showing administrators that particular approaches are legitimate ways to administer the Act.

15006. Reducing Delay and Paperwork

Public agencies should reduce delay and paperwork by:

(a) Integrating the CEQA process into early planning. (15004(c))

(b) Ensuring the swift and fair resolution of Lead Agency disputes. (15053)

(c) Identifying projects which fit within categorical exemptions and are therefore exempt from CEQA processing. (15300.4)

(d) Using Initial Studies to identify significant environmental issues and to narrow the scope of EIRs. (15063)

(e) Using a Negative Declaration when a project not otherwise exempt will not have a significant effect on the environment. (15070)

(f) Using a previously prepared EIR when it adequately addresses the proposed project. (15153)

(g) Consulting with state and local Responsible Agencies before and during preparation of an Environmental Impact Report so that the document will meet the needs of all the agencies which will use it. (15083)

(h) Urging applicants, either before or after the filing of an application, to revise projects to eliminate possible significant effects on the environment, thereby enabling the project to qualify for a Negative Declaration rather than an Environmental Impact Report. (15063(c)(2))

(i) Integrating CEQA requirements with other environmental review and consulting requirements. (Public Resources Code Section 21080.5)

(j) Eliminating duplication with federal procedures by providing for joint preparation of environmental


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documents with federal agencies and by adopting completed federal NEPA documents. (15227)

(k) Emphasizing consultation before an Environmental Impact Report is prepared, rather than submitting adversary comments on a completed document. (15082(b))

(l) Combining environmental documents with other documents such as general plans. (15166)

(m) Eliminating repetitive discussions of the same issues by using Environmental Impact Reports on programs, policies, or plans and tiering from reports of broad scope to those of narrower scope. (15152)

(n) Reducing the length of Environmental Impact Reports by means such as setting appropriate page limits. (15141)

(o) Preparing analytic rather than encyclopedic Environmental Impact Reports. (15142)

(p) Mentioning only briefly issues other than significant ones in EIRs. (15143)

(q) Writing Environmental Impact Reports in plain language. (15140)

(r) Following a clear format for Environmental Impact Reports. (15120)

(s) Emphasizing the portions of the Environmental Impact Report that are useful to decision-makers and the public and reducing emphasis on background material. (15143)

(t) Using incorporation by reference. (15150)

(u) Making comments on Environmental Impact Reports as specific as possible. (15204)

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003 and 21083, Public Resources Code.

Discussion: This section encourages agencies to reduce the time and expense previously involved in the administration of CEQA. This section highlights many specific provisions of the Guidelines that are designed to reduce both delay and paperwork. This section is designed to reduce the unnecessary delays and paperwork that have added unjustified costs to the CEQA process. Bringing these provisions together should help agencies identify and use efficient ways to administer the Act.

15007. Amendments

(a) These Guidelines will be amended from time to time to match new developments relating to CEQA.

(b) Amendments to the Guidelines apply prospectively only. New requirements in amendments will apply to steps in the CEQA process not yet undertaken by the date when agencies must comply with the amendments.

(c) If a document meets the content requirements in effect when the document is sent out for public review, the document shall not need to be revised to conform to any new content requirements in Guideline amendments taking effect before the document is finally approved.

(d) Public agencies shall comply with new requirements in amendments to the Guidelines beginning with the earlier of the following two dates:

(1) The effective date of the agency's procedures amended to conform to the new Guideline amendments; or

(2) The 120th day after the effective date of the Guideline amendments.

(e) Public agencies may implement any permissive or advisory elements of the Guidelines beginning


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with the effective date of the Guideline amendments.


Discussion: Section 15007 is intended to provide a single section that will apply to all past, current, and future amendments. This approach will avoid the need to add a new subsection to the Guidelines to explain the phase-in procedures with every new set of amendments. Subsection (a) recognizes the need to update the Guidelines periodically. Subsection (b) provides the formula for the phase-in of any new requirements.

Section 15007 is intended to provide uniform procedures after the effective date of the new amendments to the Guidelines. If a draft EIR was sent out for public review before the effective date of the amendments and the draft EIR complied with all content requirements at the time, it would not need to be changed even if the contents of a draft EIR were revised in adopted amendments. Any steps taken in processing the draft or final EIR or in making findings after approving the EIR, would have to comply with any new requirements in the Guidelines.

The same principle would apply to a project being processed with a Negative Declaration or with an EIR substitute under a certified program.

Subsection (c) provides an interpretation clarifying the content requirement for documents. It provides expressly that if a document met all content requirements in effect at the time when it was sent out for public review, the contents of the document would not need to be changed even if new amendments altering the content requirements took effect before the document was finally approved. Because the section uses the term "documents," the wording shows that the principle applies to Negative Declarations as well as EIRs.

Section 15007(d) was added to avoid any inconsistency with Section 15022. Section 15007(d) provides that agencies must comply with new amendments to the Guidelines either on the effective date of their own implementing procedures or the 120th day after the effective date of the Guidelines, whichever is earlier. This approach is necessary to provide agencies with enough time to revise their procedures and bring their process into conformity with the revised Guidelines.

Subsection (e) provides that agencies have the option of complying with new amendments to the Guidelines at an earlier time if they so choose. This approach allows agencies to take immediate advantage of any new efficiencies or shortcuts allowed in amendments but does not require compliance with the new amendments until later.
Title 14. California Code of Regulations  
Chapter 3. Guidelines for Implementation of the
California Environmental Quality Act

Article 2. General Responsibilities  
Sections 15020 to 15025

15020. General  

Each public agency is responsible for complying with CEQA and these Guidelines. A public agency must meet its own responsibilities under CEQA and shall not rely on comments from other public agencies or private citizens as a substitute for work CEQA requires the Lead Agency to accomplish. For example, a Lead Agency is responsible for the adequacy of its environmental documents. The Lead Agency shall not knowingly release a deficient document hoping that public comments will correct defects in the document.


Discussion: This section makes the point that an agency is responsible for its own compliance with CEQA.

15021. Duty to Minimize Environmental Damage and Balance Competing Public Objectives

(a) CEQA establishes a duty for public agencies to avoid or minimize environmental damage where feasible.

(1) In regulating public or private activities, agencies are required to give major consideration to preventing environmental damage.

(2) A public agency should not approve a project as proposed if there are feasible alternatives or mitigation measures available that would substantially lessen any significant effects that the project would have on the environment.

(b) In deciding whether changes in a project are feasible, an agency may consider specific economic, environmental, legal, social, and technological factors.

(c) The duty to prevent or minimize environmental damage is implemented through the findings required by Section 15091.

(d) CEQA recognizes that in determining whether and how a project should be approved, a public agency has an obligation to balance a variety of public objectives, including economic, environmental, and social factors and in particular the goal of providing a decent home and satisfying living environment for every Californian. An agency shall prepare a statement of overriding considerations as described in Section 15093 to reflect the ultimate balancing of competing public objectives when
the agency decides to approve a project that will cause one or more significant effects on the environment.


Discussion: Section 15021 brings together the many separate elements that apply to the duty to minimize environmental damage. These duties appear in the policy sections of CEQA, in the findings requirement in Section 21081, and in a number of court decisions that have built up a body of case law that is not immediately reflected in the statutory language. This section is also necessary to provide one place to explain how the ultimate balancing of the merits of the project relates to the search for feasible alternatives or mitigation measures to avoid or reduce the environmental damage.

The placement of this section early in the article on general responsibilities helps highlight this duty to prevent environmental damage. This section is an effort to provide a careful statement of the duty with its limitations and its relationship to other essential public goals.

15022. Public Agency Implementing Procedures

(a) Each public agency shall adopt objectives, criteria, and specific procedures consistent with CEQA and these Guidelines for administering its responsibilities under CEQA, including the orderly evaluation of projects and preparation of environmental documents. The implementing procedures should contain at least provisions for:

(1) Identifying the activities that are exempt from CEQA. These procedures should contain:

(A) Provisions for evaluating a proposed activity to determine if there is no possibility that the activity may have a significant effect on the environment.

(B) A list of projects or permits over which the public agency has only ministerial authority.

(C) A list of specific activities which the public agency has found to be within the categorical exemptions established by these Guidelines.

(2) Conducting Initial Studies.

(3) Preparing Negative Declarations.

(4) Preparing draft and final EIRs.

(5) Consulting with and obtaining comments from other public agencies and members of the public with regard to the environmental effects of projects.

(6) Assuring adequate opportunity and time for public review and comment on the Draft EIR or Negative Declaration.

(7) Evaluating and responding to comments received on environmental documents.

(8) Assigning responsibility for determining the adequacy of an EIR or Negative Declaration.

(9) Reviewing and considering environmental documents by the person or decision-making body who will approve or disapprove a project.

(10) Filing documents required or authorized by CEQA and these Guidelines.

(11) Providing adequate comments on environmental documents which are submitted to the public agency for review.
(12) Assigning responsibility for specific functions to particular units of the public agency.

(13) Providing time periods for performing functions under CEQA.

(b) Any district, including a school district, need not adopt objectives, criteria, and procedures of its own if it uses the objectives, criteria, and procedures of another public agency whose boundaries are coterminous with or entirely encompass the district.

(c) Public agencies should revise their implementing procedures to conform to amendments to these Guidelines within 120 days after the effective date of the amendments. During the period while the public agency is revising its procedures, the agency must conform to any statutory changes in the California Environmental Quality Act that have become effective regardless of whether the public agency has revised its formally adopted procedures to conform to the statutory changes.

(d) In adopting procedures to implement CEQA, a public agency may adopt the State CEQA Guidelines through incorporation by reference. The agency may then adopt only those specific procedures or provisions described in subsection (a) which are necessary to tailor the general provisions of the Guidelines to the specific operations of the agency. A public agency may also choose to adopt a complete set of procedures identifying in one document all the necessary requirements.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21082, 21100.2, and 21151.5, Public Resources Code.

Discussion: This section supplements the statutory requirement for every agency to have implementing procedures for CEQA. After identifying the statutory requirement, the section spells out the essential contents for the implementing procedures. Without this list of essential contents, many agencies that only occasionally work with CEQA would find that they had failed to comply with the Act when challenged over their implementing procedures.

Subsection (b) identifies the statutory allowance for a school district to use the implementing procedures of any public agency whose boundaries are coterminous with the district. The regulation then expands this authorization to allow any agency to adopt the procedures of a second agency whose boundaries are coterminous with or entirely encompass those of the first agency. This regulation is necessary to validate the common practice of many counties of having the county planning department often provide the staff work for CEQA compliance of most of the districts within the county, following county procedures.

Subsection (c) answers the often asked question of how soon agencies must bring their implementing procedures into conformance with newly adopted amendments to the Guidelines.

Subsection (d) allows a public agency to use an efficient, short method of bringing its procedures into compliance by adopting the State Guidelines through incorporation by reference. Agencies which have followed this approach have been able to reduce the size of their regulations and reduce the expense of keeping their regulations up-to-date. This section still allows public agencies the option of adopting their own complete set of procedures if they so choose.

15023. Office of Planning and Research (OPR)

(a) From time to time OPR shall review the State CEQA Guidelines and shall make recommendations for amendments to the Secretary for Resources.

(b) OPR shall receive and evaluate proposals for adoption, amendment, or repeal of categorical exemptions and shall make recommendations on the proposals to the Secretary for Resources. People making suggestions concerning categorical exemptions shall submit their recommendations to OPR with supporting information to show that the class of projects in the proposal either will or will not have a significant effect on the environment.

(c) The State Clearinghouse in the Office of Planning and Research shall be responsible for distributing environmental documents to state agencies, departments, boards, and commissions for review and comment.

(d) Upon request of a Lead Agency or a project applicant, OPR shall provide assistance in identifying the various responsible agencies and any federal agencies which have responsibility for carrying out or approving a proposed project.

(e) OPR shall ensure that state Responsible Agencies provide the necessary information to Lead Agencies in response to Notices of Preparation within, at most, 30 days after receiving a Notice of Preparation.

(f) OPR shall resolve disputes as to which agency is the Lead Agency for a project.

(g) OPR shall receive and file all notices of completion, determination, and exemption.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.4, 21083, 21086, 21087, 21108, and 21161 Public Resources Code.

Discussion: This section brings together many different requirements which apply to the Office of Planning and Research. Although some of the requirements identified in this section are statutory, others are administrative in origin. The statutory and administrative requirements are combined here to provide a comprehensive view of the OPR responsibility.

15024. Secretary for Resources

(a) The Guidelines shall be adopted by the Secretary for Resources. The Secretary shall make a finding that each class of projects given a categorical exemption will not have a significant effect on the environment.

(b) The Secretary may issue amendments to these Guidelines.

(c) The Secretary shall certify state environmental regulatory programs which meet the standards for certification in Section 21080.5, Public Resources Code.

(d) The Secretary shall receive and file notices required by certified state environmental regulatory programs.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.5, 21083, 21084, 21086, 21087, 21088, and 21152, Public Resources Code.

Discussion: This section brings together many different requirements under CEQA which apply to the Secretary for Resources and OPR. The section is included here to provide information to agencies and members of the public who are concerned with the CEQA process.

Subsection (d) has been changed to conform with amendments made to the statute by Chapter 571, Statutes of 1984. These amendments consolidated the filing of Notices of Completion, Determination and Exemption in OPR rather than with the Secretary of Resources, except for notices required for CEQA compliance under certified regulatory programs.

15025. Delegation of Responsibilities

(a) A public agency may assign specific functions to its staff to assist in administering CEQA. Functions which may be delegated include but are not limited to:

(1) Determining whether a project is exempt.

(2) Conducting an Initial Study and deciding whether to prepare a draft EIR or Negative Declaration.

(3) Preparing a Negative Declaration or EIR.

(4) Determining that a Negative Declaration has been completed within a period of 105 days.

(5) Preparing responses to comments on environmental documents.

(6) Filing of notices.

(b) The decision-making body of a public agency shall not delegate the following functions:

(1) Reviewing and considering a final EIR or approving a Negative Declaration prior to approving a project.

(2) The making of findings as required by Sections 15091 and 15093.

(c) Where an advisory body such as a planning commission is required to make a recommendation on a project to the decision-making body, the advisory body shall also review and consider the EIR or Negative Declaration in draft or final form.


Discussion: This section is a recodification of former Section 15055 with one additional feature. The section is necessary in order to identify functions in the CEQA process that a decision-making body can delegate to other parts of the Lead Agency. The agency can operate more efficiently when many functions are delegated to the staff rather than requiring the decision-making body to perform all the functions.

Subsection (b) codifies the holding in Kleist v. City of Glendale by identifying the functions that cannot be delegated. The functions of considering the environmental document and making findings in response to significant effects identified in a final EIR are fundamental to the CEQA process. These steps bring together the environmental evaluation and the decision on the project. This section is intended to assure that the environmental analysis of a project is brought to bear on the actual decision on the project. The section also serves to guide agencies away from practices that have been ruled invalid.

Subsection (c) reflects an administrative interpretation which applies the requirements of CEQA to advisory bodies. Such bodies need not and may not certify an EIR, but they should consider the effects of a project in making their recommendations. This section also suggests that advisory bodies may consider a draft EIR.
Chapter 2.5. Definitions

(Added: Chapter 1154, Statutes of 1972)

Sections 21060 to 21069

21060. Application of Definitions

Unless the context otherwise requires, the definitions in this chapter govern the construction of this division.

21060.1. Agricultural Land

(a) "Agricultural land" means prime farmland, farmland of statewide importance, or unique farmland, as defined by the United States Department of Agriculture land inventory and monitoring criteria, as modified for California.

(b) In those areas of the state where lands have not been surveyed for classifications specified in subdivision (a), "agricultural land" means land that meets the requirements of "prime agricultural land" as defined in paragraph (1), (2), (3), or (4) of subdivision (c) of Section 51201 of the Government Code.

(Added: Chapter 812, Statutes of 1993)

21060.3. Emergency

"Emergency" means a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. "Emergency" includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

(Added: Chapter 1312, Statutes of 1976)

21060.5. Environment

"Environment" means the physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance.

(Added: Chapter 1154, Statutes of 1972)

21061. Environmental Impact Report

http://ceres.ca.gov/ceqa/stat/chap2_5.html
"Environmental impact report" means a detailed statement setting forth the matters specified in Sections 21100 and 21100.1; provided that information or data which is relevant to such a statement and is a matter of public record or is generally available to the public need not be repeated in its entirety in such statement, but may be specifically cited as the source for conclusions stated therein; and provided further that such information or data shall be briefly described, that its relationship to the environmental impact report shall be indicated, and that the source thereof shall be reasonably available for inspection at a public place or public building. An environmental impact report also includes any comments which are obtained pursuant to Section 21104 or 21153, or which are required to be obtained pursuant to this division.

An environmental impact report is an informational document which, when its preparation is required by this division, shall be considered by every public agency prior to its approval or disapproval of a project. The purpose of an environmental impact report is to provide public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment; to list ways in which the significant effects of such a project might be minimized; and to indicate alternatives to such a project.

In order to facilitate the use of environmental impact reports, public agencies shall require that such reports contain an index or table of contents and a summary. Failure to include such index, table of contents, or summary shall not constitute a cause of action pursuant to Section 21167.

(Amended: Chapter 1312, Statutes of 1976)

21061.1. Feasible

"Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

(Added: Chapter 1312, Statutes of 1976)

21061.2. Land Evaluation and Site Assessment

"Land evaluation and site assessment" means a decisionmaking methodology for assessing the potential environmental impact of state and local projects on agricultural land.

(Added: Chapter 812, Statutes of 1993)

21062. Local Agency

"Local agency" means any public agency other than a state agency, board, or commission. For purposes of this division, a redevelopment agency and a Local Agency Formation Commission are local agencies, and neither is a state agency, board, or commission.
21063. Public Agency

"Public agency" includes any state agency, board, or commission, any county, city and county, city, regional agency, public district, redevelopment agency, or other political subdivision.

(Added: Chapter 1154, Statutes of 1972)

21064. Negative Declaration

"Negative declaration" means a written statement briefly describing the reasons that a proposed project will not have a significant effect on the environment and does not require the preparation of an environmental impact report.

(Added: Chapter 1312, Statutes of 1976)

21064.5. Mitigated Negative Declaration

"Mitigated negative declaration" means a negative declaration prepared for a project when the initial study has identified potentially significant effects on the environment, but (1) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (2) there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment.

(Added: Chapter 1130, Statutes of 1993; Amended: Chapter 1230, Statutes of 1994)

21065. Project

"Project" means an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following:

(a) An activity directly undertaken by any public agency.

(b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.

(c) An activity that involves the issuance to a person of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies.

(Amended: Chapter 1230, Statutes of 1994)

21065.5. Geothermal Exploratory Project

http://ceres.ca.gov/ceqa/stat/chap2_5.html

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"Geothermal exploratory project" means a project as defined in Section 21065 composed of not more than six wells and associated drilling and testing equipment, whose chief and original purpose is to evaluate the presence and characteristics of geothermal resources prior to commencement of a geothermal field development project as defined in Section 65928.5 of the Government Code. Wells included within a geothermal exploratory project must be located at least onehalf mile from geothermal development wells which are capable of producing geothermal resources in commercial quantities.

(Added: Chapter 1271, Statutes of 1978)

21066. Person

"Person" includes any person, firm, association, organization, partnership, business, trust, corporation, limited liability company, company, district, county, city and county, city, town, the state, and any of the agencies and political subdivisions of those entities, and, to the extent permitted by federal law, the United States, or any of its agencies or political subdivisions.

(Amended: Chapter 272, Statutes of 1998)

21067. Lead Agency

"Lead Agency" means the public agency which has the principal responsibility for carrying out or approving a project which may have a significant effect upon the environment.

21068. Significant Effect on the Environment

"Significant effect on the environment" means a substantial, or potentially substantial, adverse change in the environment.

(Added: Chapter 1312, Statutes of 1976)

21068.5. Tiering or Tier

"Tiering" or "tier" means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report.

(Added: Chapter 967, Statutes of 1983)

21069. Responsible Agency

"Responsible Agency" means a public agency, other than the lead agency which has
responsibility for carrying out or approving a project.

(Added: Chapter 1312, Statutes of 1976)
21080. Application to Discretionary Projects; Olympic Games; Rates - Tolls - Fares; Proposition 13 Adjustments; Categorical Exemptions; Rail Service; Commuter Service; Mass Transit Service; Regional Transportation Programs; Out-of-State Projects; Local Agency Implementation of State Regulation Pursuant to Certified Regulatory Program; Negative Declarations

(a) Except as otherwise provided in this division, this division shall apply to discretionary projects proposed to be carried out or approved by public agencies, including, but not limited to, the enactment and amendment of zoning ordinances, the issuance of zoning variances, the issuance of conditional use permits, and the approval of tentative subdivision maps unless the project is exempt from this division.

(b) This division does not apply to any of the following activities:

(1) Ministerial projects proposed to be carried out or approved by public agencies.

(2) Emergency repairs to public service facilities necessary to maintain service.

(3) Projects undertaken, carried out, or approved by a public agency to maintain, repair, restore, demolish, or replace property or facilities damaged or destroyed as a result of a disaster in a disaster-stricken area in which a state of emergency has been proclaimed by the Governor pursuant to Chapter 7 (commencing with Section 8550) of Division 1 of Title 2 of the Government Code.

(4) Specific actions necessary to prevent or mitigate an emergency.

(5) Projects which a public agency rejects or disapproves.

(6) Actions undertaken by a public agency relating to any thermal powerplant site or facility, including the expenditure, obligation, or encumbrance of funds by a public agency for planning, engineering, of design purposes, or for the conditional sale or purchase of equipment, fuel, water (except groundwater), steam, or power for a thermal powerplant, if the powerplant site and related facility will be the subject of an


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environmental impact report, negative declaration, or other document, prepared pursuant to a regulatory program certified pursuant to Section 21080.5, which will be prepared by the State Energy Resources Conservation and Development Commission, by the Public Utilities Commission, or by the city or county in which the powerplant and related facility would be located if the environmental impact report, negative declaration, or document includes the environmental impact, if any, of the action described in this paragraph.

(7) Activities or approvals necessary to the bidding for, hosting or staging of, and funding or carrying out of, an Olympic games under the authority of the International Olympic Committee, except for the construction of facilities necessary for the Olympic games.

(8) The establishment, modification, structuring, restructuring, or approval of rates, tolls, fares, or other charges by public agencies which the public agency finds are for the purpose of (A) meeting operating expenses, including employee wage rates and fringe benefits, (B) purchasing or leasing supplies, equipment, or materials, (C) meeting financial reserve needs and requirements, (D) obtaining funds for capital projects necessary to maintain service within existing service areas, or (E) obtaining funds necessary to maintain those intracity transfers as are authorized by city charter. The public agency shall incorporate written findings in the record of any proceeding in which an exemption under this paragraph is claimed setting forth with specificity the basis for the claim for exemption.

(9) All classes of projects designated pursuant to Section 21084.

(10) A project for the institution or increase of passenger or commuter services on rail or highway rights-of-way already in use, including modernization of existing stations and parking facilities.

(11) A project for the institution or increase of passenger or commuter service on high-occupancy vehicle lanes already in use, including the modernization of existing stations and parking facilities.

(12) Facility extensions not to exceed four miles in length which are required for the transfer of passengers from or to exclusive mass transit guideway or busway public transit services.

(13) A project for the development of a regional transportation improvement program, the state transportation improvement program, or a congestion management program prepared pursuant to Section 65089 of the Government Code.

(14) Any project or portion thereof located in another state which will be subject to environmental impact review pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. Sec. 4321 et seq.) or similar state laws of that state. Any emissions or discharges that would have a significant effect on the environment in this state are subject to this division.

(15) Projects undertaken by a local agency to implement a rule or regulation imposed by


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a state agency, board, or commission under a certified regulatory program pursuant to Section 21080.5. Any site-specific effect of the project which was not analyzed as a significant effect on the environment in the plan or other written documentation required by Section 21080.5 is subject to this division.

(c) If a lead agency determines that a proposed project, not otherwise exempt from this division, would not have a significant effect on the environment, the lead agency shall adopt a negative declaration to that effect. The negative declaration shall be prepared for the proposed project in either of the following circumstances:

1) There is no substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment.

2) An initial study identifies potentially significant effects on the environment, but (A) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (B) there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment.

(d) If there is substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment, an environmental impact report shall be prepared.

(e)(1) For the purposes of this section and this division, substantial evidence includes fact, a reasonable assumption predicated upon fact, or expert opinion supported by fact.

2) Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence of social or economic impacts that do not contribute to, or are not caused by, physical impacts on the environment is not substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.

(f) As a result of the public review process for a mitigated negative declaration, including administrative decisions and public hearings, the lead agency may conclude that certain mitigation measures identified pursuant to paragraph (2) of subdivision (c) are infeasible or otherwise undesirable. In those circumstances, the lead agency, prior to approving the project, may delete those mitigation measures and substitute for them other mitigation measures that the lead agency finds, after holding a public hearing on the matter, are equivalent or more effective in mitigating significant effects on the environment to a less than significant level and that do not cause any potentially significant effect on the environment. If those new mitigation measures are made conditions of project approval or are otherwise made part of the project approval, the deletion of the former measures and the substitution of the new mitigation measures shall not constitute an action or circumstance requiring recirculation of the mitigated negative declaration.

(g) Nothing in this section shall preclude a project applicant or any other person from


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challenging, in and administrative or judicial proceeding, the legality of a condition of project approval imposed by the lead agency. If, however, any condition of project approval set aside by either an administrative body or court was necessary to avoid or lessen the likelihood of the occurrence of a significant effect on the environment, the lead agency's approval of the negative declaration and project shall be invalid and a new environmental review process shall be conducted before the project can be reapproved, unless the lead agency substitutes a new condition that the lead agency finds, after holding a public hearing on the matter, is equivalent to, or more effective in, lessening or avoiding significant effects on the environment and that does not cause any potentially significant effect on the environment.

(Amended: Chapter 547, Statutes of 1996; Chapter 1230, Statutes of 1994; Chapter 1131, Statutes of 1993)

21080.01. California Men's Colony West Facility; Reopening and Operation

This division shall not apply to any activity or approval necessary for the reopening and operation of the California Men's Colony West Facility in San Luis Obispo County.

(Added: Chapter 958, Statutes of 1983)

21080.02. Kings County Prison Facilities

This division shall not apply to any activity or approval necessary to planning, design, site, acquisition, construction, operation, or maintenance of the new prison facility at or in the vicinity of Corcoran in Kings County as authorized by the act that enacted this section.

(Added: Chapter 931, Statutes of 1985)

21080.03. Kings and Amador (Ione) Counties Prison Facilities

This division shall not apply to any activity or approval necessary for or incidental to the location, development, construction, operation, or maintenance of the prison in the County of Kings, authorized by Section 9 of Chapter 958 of the Statutes of 1983, as amended, and of the prison in the County of Amador (Ione), authorized by Chapter 957 of the Statutes of 1983, as amended.

(Added: Chapter 931, Statutes of 1985)

21080.04. Rocktram-Krug Passenger Rail Service Project

(a) Notwithstanding paragraph (10) of subdivision (b) of Section 21080, this division applies to a project for the institution of passenger rail service on a line paralleling State Highway 29 and running from Rocktram to Krug in the Napa Valley. With respect to that project, and for the purposes of this division, the Public Utilities Commission is the lead agency.


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(b) It is the intent of the Legislature in enacting this section to abrogate the decision of the California Supreme Court "that Section 21080, subdivision (b) (11), exempts Wine Train's institution of passenger service on the Rocktrum-Krug line from the requirements of CEQA" in Napa Valley Wine Train, Inc. v. Public Utilities Com., 50 Cal.3d 370.

(e) Nothing in this section is intended to affect or apply to, or to confer jurisdiction upon the Public Utilities Commission with respect to, any other project involving rail service.

(Amended: Chapter 91, Statutes of 1995)

21080.05. San Francisco Peninsula Commute Service Project

This division does not apply to a project by a public agency to lease or purchase the rail right-of-way used for the San Francisco Peninsula commute service between San Francisco and San Jose, together with all branch and spur lines, including the Dumbarton and Vasona lines.

(Added: Chapter 1283, Statutes of 1989)

21080.07. Riverside and Del Norte Counties Prison Facilities

This division shall not apply to any activity or approval necessary for or incidental to planning, design, site acquisition, construction, operation, or maintenance of the new prison facilities located in any of the following places:

(a) The County of Riverside.

(b) The County of Del Norte.

(Added: Chapter 933, Statutes of 1985)

21080.08. Funding by Rural Economic Development Infrastructure Panel

This division shall not apply to any activity or approval necessary for or incidental to project funding, or the authorization for the expenditure of funds for the project, by the Rural Economic Development Infrastructure Panel pursuant to Article 5 (commencing with Section 15373.6) of Chapter 2.5 of Part 6.7 of Division 3 of Title 2 of the Government Code.

(Added: Chapter 1286, Statutes of 1987)

21080.09. Public Higher Education

(a) For purposes of this section, the following definitions apply:

(1) "Public higher education" has the same meaning as specified in Section 66010 of the Education Code.

(2) "Long range development plan" means a physical development and land use plan to meet the academic and institutional objectives for a particular campus or medical center of public higher education.

(b) The selection of a location for a particular campus and the approval of a long range development plan are subject to this division and require the preparation of an environmental impact report. Environmental effects relating to changes in enrollment levels shall be considered for each campus or medical center of public higher education in the environmental impact report prepared for the long range development plan for the campus or medical center.

(c) The approval of a project on a particular campus or medical center of public higher education is subject to this division and may be addressed, subject to the other provisions of this division, in a tiered environmental analysis based upon a long range development plan environmental impact report.

(d) Compliance with this section satisfies the obligations of public higher education pursuant to this division to consider the environmental impact of academic and enrollment plans as they affect campuses or medical centers, provided that any such plans shall become effective for a campus or medical center only after the environmental effects of those plans have been analyzed as required by this division in a long range development plan environmental impact report or tiered analysis based upon that environmental impact report for that campus or medical center, and addressed as required by this division.

(Added: Chapter 659, Statutes of 1989)

21080.1. Determining Environmental Impact

(a) The lead agency shall be responsible for determining whether an environmental impact report, a negative declaration, or a mitigated negative declaration shall be required for any project which is subject to this division. That determination shall be final and conclusive on all persons, including responsible agencies, unless challenged as provided in Section 21167.

(b) In the case of a project described in subdivision (c) of Section 21065, the lead agency shall, upon the request of a potential applicant, provide for consultation prior to the filing of the application regarding the range of actions, potential alternatives, mitigation measures, and any potential and significant effects on the environment of the project.

(Amended: Chapter 1230, Statutes of 1994; Chapter 1130, Statutes of 1993)

21080.2. 30 Days

In the case of a project described in subdivision (c) of Section 21065, the determination required by Section 21080.1 shall be made within 30 days from the date on which an application for a project has been received and accepted as complete by the lead agency.


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This period may be extended 15 days upon the consent of the lead agency and the project applicant.

(Amended: Chapter 586, Statutes of 1984)

21080.3. Consultation With Other Agencies

(a) Prior to determining whether a negative declaration or environmental impact report is required for a project, the lead agency shall consult with all responsible agencies and with any other public agency which has jurisdiction by law over natural resources affected by the project which are held in trust for the people of the State of California. Prior to that required consultation, the lead agency may informally contact any such agency.

(b) In order to expedite the requirements of subdivision (a), the Office of Planning and Research, upon request of a lead agency, shall assist the lead agency in determining the various responsible agencies for a proposed project. In the case of a project described in subdivision (c) of Section 21065, the request may also be made by the project applicant.

(Amended: Chapter 1130, Statutes of 1993)

21080.4. Notices of Preparation; Scope and Content; OPR Assistance

(a) If a lead agency determines that an environmental impact report is required for a project, the lead agency shall immediately send notice of that determination by certified mail or an equivalent procedure to each responsible agency, the Office of Planning and Research, and to those public agencies having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California. Upon receipt of the notice, each responsible agency, the office, and each public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California shall specify to the lead agency the scope and content of the environmental information that is germane to the statutory responsibilities of that responsible agency, the office, or public agency in connection with the proposed project and which, pursuant to the requirements of this division, shall be included in the environmental impact report. The information shall be specified in writing and shall be communicated to the lead agency by certified mail or equivalent procedure not later than 30 days after the date of receipt of the notice of the lead agency's determination. The lead agency shall request similar guidance from appropriate federal agencies.

(b) To expedite the requirements of subdivision (a), the lead agency, or any responsible agency, the Office of Planning and Research, or public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, may request one or more meetings between representatives of those agencies and the office for the purpose of assisting the lead agency to determine the scope and content of the environmental information that any of those responsible agencies, the office, or public agencies may require. In the case of a project described in subdivision (c) of Section 21065, the request may also be made by the project applicant. The meetings shall be convened by the lead agency as soon as possible, but not later
than 30 days after the date that the meeting was requested.

c) To expedite the requirements of subdivision (a), the Office of Planning and Research, upon request of a lead agency, shall assist the lead agency in determining the various responsible agencies, public agencies having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, and any federal agencies that have responsibility for carrying out or approving a proposed project. In the case of a project described in subdivision (c) of Section 21065, that such a request may also be made by the project applicant.

d) With respect to the Department of Transportation, and with respect to any other state agency that is a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, subject to the requirements of subdivision (a), the Office of Planning and Research shall ensure that the information required by subdivision (a) is transmitted to the lead agency, and that affected agencies are notified regarding meetings to be held upon request pursuant to subdivision (b), within the required time period.

(Amended: Chapter 1201, Statutes of 1992; Amended: Chapter 415, Statutes of 1997; Amended: Chapter 738, Statutes of 2000)

21080.5. Certified Regulatory Programs

(a) Except as provided in Section 21158.1, when the regulatory program of a state agency, board or commission requires a plan or other written documentation, containing environmental information and complying with the requirements of paragraph (3) of subdivision (d), to be submitted in support of any activity listed in subdivision (b), the plan or other written documentation may be submitted in lieu of the environmental impact report required by this division if the Secretary of the Resources Agency has certified the regulatory program pursuant to this section.

(b) This section applies only to regulatory programs or portions thereof which involve either of the following:

(1) The issuance to a person of a lease, permit, license, certificate, or other entitlement for use.

(2) The adoption or approval of standards, rules, regulations, or plans for use in the regulatory program.

(c) A regulatory program certified pursuant to this section is exempt from the provisions of Chapter 3 (commencing with Section 21100), and Chapter 4 (commencing with Section 21150), and Section 21167, except as provided in Article 2 (commencing with Section 21157) of Chapter 4.5.

(d) To qualify for certification pursuant to this section, a regulatory program shall require the utilization of an interdisciplinary approach that will ensure the integrated use of the natural and social sciences in decisionmaking and shall meet all of the following criteria:


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(1) The enabling legislation of the regulatory program does both of the following:

(A) Includes protection of the environment among its principal purposes.

(B) Contains authority for the administering agency to adopt rules and regulations for the protection of the environment, guided by standards set forth in the enabling legislation.

(2) The rules and regulations adopted by the administering agency for the regulatory program do all of the following:

(A) Require that an activity will not be approved or adopted as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen any significant adverse effect which the activity may have on the environment.

(B) Include guidelines for the orderly evaluation of proposed activities and the preparation of the plan or other written documentation in a manner consistent with the environmental protection purposes of the regulatory program.

(C) Require the administering agency to consult with all public agencies which have jurisdiction, by law, with respect to the proposed activity.

(D) Require that final action on the proposed activity include the written responses of the issuing authority to significant environmental points raised during the evaluation process.

(E) Require the filing of a notice of the decision by the administering agency on the proposed activity with the Secretary of the Resources Agency. Those notices shall be available for public inspection, and a list of the notices shall be posted on a weekly basis in the Office of the Resources Agency. Each list shall remain posted for a period of 30 days.

(F) Require notice of the filing of the plan or other written documentation to be made to the public and to any person who requests, in writing, notification. The notification shall be made in a manner that will provide the public or any person requesting notification with sufficient time to review and comment on the filing.

(3) The plan or other written documentation required by the regulatory program does both of the following:

(A) Includes a description of the proposed activity with alternatives to the activity, and mitigation measures to minimize any significant adverse effect on the environment of the activity.

(B) Is available for a reasonable time for review and comment by other public agencies and the general public.

(c)(1) The Secretary of the Resources Agency shall certify a regulatory program which


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the secretary determines meets all the qualifications for certification set forth in this section, and withdraw certification on determination that the regulatory program has been altered so that it no longer meets those qualifications. Certification and withdrawal of certification shall occur only after compliance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

(2) In determining whether or not a regulatory program meets the qualifications for certification set forth in this section, the inquiry of the secretary shall extend only to the questions of whether the regulatory program meets the generic requirements of subdivision (d). The inquiry shall not extend to individual decisions to be reached under the regulatory program, including the nature of specific alternatives or mitigation measures which might be proposed to lessen any significant adverse effect on the environment of the activity.

(3) If the secretary determines that the regulatory program submitted for certification does not meet the qualifications for certification set forth in this section, the secretary shall adopt findings setting forth the reasons for the determination.

(f) After a regulatory program has been certified pursuant to this section, any proposed change in the program which could affect compliance with the qualifications for certification specified in subdivision (d) may be submitted to the Secretary of the Resources Agency for review and comment. The scope of the secretary's review shall extend only to the question of whether the regulatory program meets the generic requirements of subdivision (d). The review shall not extend to individual decisions to be reached under the regulatory program, including specific alternatives or mitigation measures which might be proposed to lessen any significant adverse effect on the environment of the activity. The secretary shall have 30 days from the date of receipt of the proposed change to notify the state agency, board, or commission whether the proposed change will alter the regulatory program so that it no longer meets the qualification for certification established in this section and will result in a withdrawal of certification as provided in this section.

(g) Any action or proceeding to attack, review, set aside, void, or annul a determination or decision of a state agency, board, or commission approving or adopting a proposed activity under a regulatory program which has been certified pursuant to this section on the basis that the plan or other written documentation prepared pursuant to paragraph (3) of subdivision (d) does not comply with the provisions of this section shall be commenced not later than 30 days from the date of the filing of notice of the approval or adoption of the activity.

(h)(1) Any action or proceeding to attack, review, set aside, void, or annul a determination of the Secretary of the Resources Agency to certify a regulatory program pursuant to this section on the basis that the regulatory program does not comply with the provisions of this section shall be commenced within 30 days from the date of certification by the secretary.

(2) In any action brought pursuant to paragraph (1), the inquiry shall extend only to whether there was a prejudicial abuse of discretion by the secretary. Abuse of discretion is established if the secretary has not proceeded in a manner required by law or if the
determination is not supported by substantial evidence.

(i) For purposes of this section, any county agricultural commissioner is a state agency.

(j) For purposes of this section, any air quality management district or air pollution control district is a state agency, except that the approval, if any, by such a district of a nonattainment area plan is subject to this section only if, and to the extent that, the approval adopts or amends rules or regulations.

(k) This section shall become operative on January 1, 1991.

(Added: Chapter 1284, Statutes of 1987; Amended: Chapter 444, Statutes of 1996)

21080.6. (Added: Chapter 1070, Statutes of 1993; Repealed: January 1, 1997 by its own terms)

21080.7. Housing or Neighborhood Commercial Facilities

(a) No environmental impact report or negative declaration is required for any project involving the construction of housing or neighborhood commercial facilities in an urbanized area if the lead agency does all of the following:

(1) Finds, after giving notice pursuant to subdivision (c) or (d) of Section 21092 and following the procedure prescribed by law or regulation which would be necessary to make a determination pursuant to Section 21080.1, all of the following:

(A) The project is consistent with a comprehensive regulatory document which has been adopted pursuant to Article 8 (commencing with Section 65450) of Chapter 3 of Title 7 of the Government Code or, in the coastal zone, a local coastal program certified pursuant to Article 2 (commencing with Section 30510) of Chapter 6 of Division 20.

(B) For purposes of this section, the plan or program was adopted pursuant to the procedures established by Article 8 (commencing with Section 65450) of Chapter 3 of Title 7 of the Government Code not more than five years prior to the finding made pursuant to this section.

(C) The plan or program has been the subject of an environmental impact report.

(D) The environmental impact report is sufficiently detailed so that the significant effects on the environment of the project and measures necessary to mitigate or avoid those effects can be determined, including any significant physical effects on existing structures and neighborhoods of historical or aesthetic significance that exist in the area covered by the plan or program and measures necessary to mitigate or avoid those effects.

(2) Makes one or more of the findings required pursuant to Section 21081.

(3) Files a notice of the decision on the proposed activity with the county clerk. Those notices shall be available for public inspection, and a list of the notices shall be posted on http://www.ceres.ca.gov/ceqa/stat/chap2_6.html

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a weekly basis in the office of the county clerk. Each list shall remain posted for a period of 30 days.

(b) As used in this section:

(1) "Neighborhood commercial facilities" means those commercial facilities which are an integral part of a project involving the construction of housing and which will serve the residents of the housing.

(2) "Urbanized area" means a central city or cities and surrounding closely settled territory, as defined in the United States Department of Commerce Bureau of the Census in the Federal Register, Volume 39, Number 85, for Wednesday, May 1, 1974, as pages 15202 and 15203, and as periodically updated.

(Amended: Chapter 1130, Statutes of 1993)

21080.8. Mobilehome Park Conversion

This division does not apply to the conversion of an existing rental mobilehome park to a resident initiated subdivision, cooperative, or condominium for mobile homes if the conversion will not result in an expansion of or change in existing use of the property.

(Added: Chapter 272, Statutes of 1990.)

21080.9. Local Coastal Programs

This division shall not apply to activities and approvals by any local government, as defined in Section 30109, or any state university or college, as defined in Section 30119, as necessary for the preparation and adoption of a local coastal program or long-range land use development plan pursuant to Division 20 (commencing with Section 30000); provided, however, that certification of a local coastal program or long-range land use development plan by the California Coastal Commission pursuant to Chapter 6 (commencing with Section 30500) of Division 20 shall be subject to the requirements of this division. For the purposes of Section 21080.5, a certified local coastal program or long-range land use development plan constitutes a plan for use in the California Coastal Commission's regulatory program.

(Amended: Chapter 961, Statutes of 1979)

21080.10. General Plan Time Extension; Low/Moderate Income Housing

This division shall not apply to any of the following:

(a) An extension of time, granted pursuant to Section 65361 of the Government Code, for the preparation and adoption of one or more elements of a city or county general plan.

(b) Actions taken by the Department of Housing and Community Development or the California Housing Finance Agency to provide financial assistance or insurance for the

development and construction of residential housing for persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code, if the project which is the subject of the application for financial assistance or insurance will be reviewed pursuant to this division by another public agency.

(c)(1) Any development project which consists of the construction, conversion, or use of residential housing for agricultural employees, as defined in paragraph (2), that is affordable to lower-income households, as defined in Section 50079.5 of the Health and Safety Code, if there is no public financial assistance for the development project and the developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for lower-income households for a period of at least 15 years, or any development project that consists of the construction, conversion, or use of residential housing for agricultural employees, as defined in paragraph (2), that is affordable to low- and moderate-income households, as defined in paragraph (2) of subdivision (b) of Section 65589.5 of the Government Code, if there is public financial assistance for the development project and the developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for low- and moderate-income households for a period of at least 15 years, if either type of development project meets all of the following requirements:

(A)(i) If the development project is proposed for an urbanized area, it is located on a project site which is adjacent, on at least two sides, to land that has been developed, and consists of not more than 45 units, or is housing for a total of 45 or fewer agricultural employees if the housing consists of dormitories, barracks, or other group living facilities.

(ii) If the development project is proposed for a nonurbanized area, it is located on a project site zoned for general agricultural use, and consists of not more than 20 units, or is housing for a total of 20 or fewer agricultural workers if the housing consists of dormitories, barracks, or other group living facilities.

(B) The development project is consistent with the jurisdiction's general plan as it existed on the date that the application was deemed complete.

(C) The development project is consistent with the zoning designation, as specified in the zoning ordinance as it existed on the date that the application was deemed complete, unless the zoning is inconsistent with the general plan because the local agency has not rezoned the property to bring it into conformity with the general plan.

(D) The development project is not more than five acres in area, except that a project site located in an area with a population density of at least 1,000 persons per square mile shall not be more than two acres in area.

(E) The development project site can be adequately served by utilities.

(F) The development project site has no value as a wildlife habitat.

(G) The development project site is not included on any list of facilities and sites compiled pursuant to Section 65962.5 of the Government Code.

(H) The development project will not involve the demolition of, or any substantial adverse change, in any structure that is listed, or is determined to be eligible for listing, in the California Register of Historic Resources.

(2) As used in paragraph (1), "residential housing for agricultural employees" means housing accommodations for an agricultural employee, as defined in subdivision (b) of Section 1140.4 of the Labor Code.

(3) As used paragraph (1), "urbanized area" means either of the following:

(A) An area with a population density of at least 1,000 persons per square mile.

(B) An area with a population density of less than 1,000 persons per square mile that is identified as an urban area in a general plan adopted by a local government, and was not designated, on the date that the application was deemed complete, as an area reserved for future urban growth.

(4) This division shall apply to any development project described in this subdivision if a public agency which is carrying out or approving the development project determines that there is a reasonable possibility that the project, if completed, would have a significant effect on the environment due to unusual circumstances, or that the cumulative impact of successive projects of the same type in the same area over time would be significant.

(Amended: Chapter 1058, Statutes of 1994)

21080.11. Title and Boundary Problems

This division shall not apply to settlements of title and boundary problems by the State Lands Commission and to exchanges or leases in connection with those settlements.

(Added: Chapter 1463, Statutes of 1982)

21080.12. Storm Damage Repair

(a) This division does not apply to the repair, reconstruction, restoration, or rehabilitation of a public facility or private levee damaged or destroyed by the storms and floods of 1997 in a disaster-stricken area of a county for which the Governor has proclaimed a state of emergency, so long as the repair, reconstruction, restoration, or rehabilitation is limited to restoring the condition of the public facility or private levee as it was immediately prior to the storms and floods of 1997.

(b) This section shall remain in effect only until January 1, 1999, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 1999, deletes or extends that date.


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(Added: Chapter 4, Statutes of 1997)

21080.13. Railroad Grade Separation Project

This division shall not apply to any railroad grade separation project which eliminates an existing grade crossing or which reconstructs an existing grade separation.

(Added: Chapter 58, Statutes of 1982)

21080.14. Affordable Housing Projects in Urbanized Areas

(a) Except as provided in subdivision (c), this division does not apply to any development project that consists of the construction, conversion, or use of residential housing consisting of not more than 100 units in an urbanized area that is affordable to lower income households, as defined in Section 50079.5 of the Health and Safety Code, if the developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for lower income households for a period of at least 15 years, or that is affordable to low- and moderate-income households, as defined in paragraph (2) of subdivision (h) of Section 65589.5 of the Government Code, if the developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for low- and moderate-income households at monthly housing costs as determined pursuant to paragraph (2) of subdivision (h) of Section 65589.5 of the Government Code, if the developer provides sufficient legal commitments to ensure continued availability of units for the lower income households for 30 years as provided in paragraph (3) of subdivision (h) of Section 65589.5 of the Government Code, and the development project meets all of the following requirements:

(1) The development project is consistent with the jurisdiction's general plan or any applicable specific plan or local coastal program as it existed on the date that the application was deemed complete.

(2) The development project is consistent with the zoning designation, as specified in the zoning ordinance as it existed on the date that the application was deemed complete, unless the zoning is inconsistent with the general plan because the local agency has not rezoned the property to bring it into conformity with the general plan.

(3) The project site is an infill site that has been previously developed for urban uses, or the immediately contiguous properties surrounding the project site are, or previously have been, developed for urban uses.

(4) The project site is not more than five acres in area.

(5) The project site can be adequately served by utilities.

(6) The project site has no value as a wildlife habitat.


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(7) The project site is not included on any list of facilities and sites compiled pursuant to Section 65962.5 of the Government Code.

(8) The project site is subject to an assessment prepared by a California registered environmental assessor to determine the presence of hazardous contaminants on the site and the potential for exposure of site occupants to significant health hazards from nearby properties and activities. If hazardous contaminants on the site are found, the contaminants shall be removed or any significant effects of those contaminants shall be mitigated to a level of insignificance. If the potential for exposure to significant health hazards from surrounding properties or activities is found to exist, the effects of the potential exposure shall be mitigated to a level of insignificance.

(9) The project will not involve the demolition of, or any substantial adverse change in, any district, landmark, object, building, structure, site, area, or place that is listed, or determined to be eligible for listing, in the California Register of Historical Resources.

(b) As used in subdivision (a), "urbanized area" means an area that has a population density of at least 1,000 persons per square mile.

(c) Notwithstanding subdivision (a), this division does apply to a development project described in subdivision (a) if there is a reasonable possibility that the development project would have a significant effect on the environment or the residents of the development project due to unusual circumstances or due to related or cumulative impacts of reasonably foreseeable projects in the vicinity of the development project.

(Added: Chapter 1230, Statutes of 1994; Amended: Chapter 415, Statutes of 1997)


21080.17. Construction of Dwelling Units and Second Units

This division does not apply to the adoption of an ordinance by a city or county to implement the provisions of Section 65852.1 or Section 65852.2 of the Government Code.

(Added: Chapter 1013, Statutes of 1983)

21080.18. Closing of Public School K, 1-12

This division does not apply to the closing of any public in which kindergarten or any of grades 1 through 12 is maintained or the transfer of students from that public school to another school if the only physical changes involved are categorically exempt under Chapter 3 (commencing with Section 15000) of Division 6 of Title 14 of the California Administrative Code.

(Amended: Chapter 1316, Statutes of 1986)

21080.19. Restriping of Streets or Highways

This division does not apply to a project for restriping of streets or highways to relieve traffic congestion.

(Added: Chapter 750, Statutes of 1984)

21080.21. Right-of-Way

This division does not apply to any project of less than one mile in length within a public street or highway or any other public right-of-way for the installation of a new pipeline or the maintenance, repair, restoration, reconditioning, relocation, replacement, removal, or demolition of an existing pipeline. For purposes of this section, "pipeline" includes subsurface facilities but does not include any surface facility related to the operation of the underground facility.

(Added: Chapter 1650, Statutes of 1984)

21080.22. General Plan Amendments

(a) This division does not apply to activities and approvals by a local government necessary for the preparation of general plan amendments pursuant to Section 29763, except that the approval of general plan amendments by the Delta Protection Commission is subject to the requirements of this division.

(b) For purposes of Section 21080.5, a general plan amendment is a plan required by the regulatory program of the Delta Protection Commission.

(Added: Chapter 898, Statutes of 1992)

21080.23. Existing Hazardous Liquid Pipelines

(a) This division does not apply to any project which consists of the inspection, maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of an existing pipeline, as defined in subdivision (a) of Section 51010.5 of the Government Code, or any valve, flange, meter, or other piece of equipment that is directly attached to the pipeline, if the project meets all of the following conditions:

(1) (A) The project is less than eight miles in length.

(B) Notwithstanding subparagraph (A), actual construction and excavation activities undertaken to achieve the maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of an existing pipeline are not undertaken over a length of more than one-half mile at any one time.

(2) The project consists of a section of pipeline that is not less than eight miles from any section of pipeline that has been subject to an exemption pursuant to this section in the past 12 months.

(3) The project is not solely for the purpose of excavating soil that is contaminated by

hazardous materials, and, to the extent not otherwise expressly required by law, the party undertaking the project immediately informs the lead agency of the discovery of contaminated soil.

(4) To the extent not otherwise expressly required by law, the person undertaking the project has, in advance of undertaking the project, prepared a plan that will result in notification of the appropriate agencies so that they may take action, if determined to be necessary, to provide for the emergency evacuation of members of the public who may be located in close proximity to the project.

(5) Project activities are undertaken within an existing right-of-way and the right-of-way is restored to its condition prior to the project.

(6) The project applicant agrees to comply with all conditions otherwise authorized by law, imposed by the city or county planning department as part of any local agency permit process, that are required to mitigate potential impacts of the proposed project, and to otherwise comply with the Keene-Nejedly California Wetlands Preservation Act (Chapter 7 (commencing with Section 5810) of Division 5), the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code), and other applicable state laws, and with all applicable federal laws.

(b) If a project meets all of the requirements of subdivision (a), the person undertaking the project shall do all of the following:

(1) Notify, in writing, any affected public agency, including, but not limited to, any public agency having permit, land use, environmental, public health protection, or emergency response authority of the exemption of the project from this division by subdivision (a).

(2) Provide notice to the public in the affected area in a manner consistent with paragraph (3) of subdivision (b) of Section 21092.

(3) In the case of private rights-of-way over private property, receive from the underlying property owner permission for access to the property.

(4) Comply with all conditions otherwise authorized by law, imposed by the city or county planning department as part of any local agency permit process, that are required to mitigate potential impacts of the proposed project, and otherwise comply with the Keene-Nejedly California Wetlands Preservation Act (Chapter 7 (commencing with Section 5810) of Division 5), the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code), and other applicable state laws, and with all applicable federal laws.

(c) Prior to January 1, 1999, this section shall not apply to ARCO Pipeline Company's crude oil pipelines designated as Crude Oil Line 1, from Tejon Station south to its terminus, and Crude Oil Line 90.

(d) This section does not apply to either of the following:


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(1) A project in which the diameter of the pipeline is increased.

(2) A project undertaken within the boundaries of an oil refinery.

(Added: Chapter 765, Statutes of 1996)

21080.24. Air Quality Permits

This division does not apply to the issuance, modification, amendment, or renewal of any permit by an air pollution control district or air quality management district pursuant to Title V, as defined in Section 39053.3 of the Health and Safety Code, or pursuant to a district Title V program established under Sections 42301.10, 42301.11, and 42301.12 of the Health and Safety Code, unless the issuance, modification, amendment, or renewal authorizes a physical or operational change to a source or facility.

(b) Nothing in this section is intended to result in the application of this division to any physical or operational change which, prior to January 1, 1995, was not subject to this division.

(Added: Chapter 418, Statutes of 1994)

21080.26. Water Fluoridation

This division does not apply to minor alterations to utilities made for the purposes of complying with Sections 4026.7 and 4026.8 of the Health and Safety Code or regulations adopted thereunder.

(Added: Chapter 660, Statutes of 1995)

21080.32. Publicly Owned Transit Agencies

(a) This section shall only apply to publicly owned transit agencies, but shall not apply to any publicly owned transit agency created pursuant to Section 130050.2 of the Public Utilities Code.

(b) Except as provided in subdivision (c), and in accordance with subdivision (d), this division does not apply to actions taken on or after July 1, 1995, by a publicly owned transit agency to implement budget reductions caused by the failure of agency revenues to adequately fund agency programs and facilities.

(c) This section does not apply to any action to reduce or eliminate a transit service, facility, program, or activity that was approved or adopted as a mitigation measure in any environmental document authorized by this division or the National Environmental Policy Act (42 U.S.C. Sec. 4321 et seq.) or to any state or federal requirement that is imposed for the protection of the environment.

(d) (1) This section applies only to actions taken after the publicly owned transit agency has made a finding that there is a fiscal emergency caused by the failure of agency
revenues to adequately fund agency programs and facilities, and after the publicly owned transit agency has held a public hearing to consider those actions. A publicly owned transit agency that has held such a hearing shall respond within 30 days at a regular public meeting to suggestions made by the public at the initial public hearing. Those actions shall be limited to projects defined in subdivision (a) or (b) of Section 21065 which initiate or increase fees, rates, or charges charged for any existing public service, program, or activity; or reduce or eliminate the availability of an existing publicly owned transit service, facility, program, or activity.

(2) For purposes of this subdivision, "fiscal emergency," when applied to a publicly owned transit agency, means that the agency is projected to have negative working capital within one year from the date that the agency makes the finding that there is a fiscal emergency pursuant to this section. Working capital shall be determined by adding together all unrestricted cash, unrestricted short-term investments, and unrestricted short-term accounts receivable and then subtracting unrestricted accounts payable. Employee retirement funds, including Internal Revenue Code Section 457 deferred compensation plans and Section 401(k) plans, health insurance reserves, bond payment reserves, workers' compensation reserves, and insurance reserves, shall not be factored into the formula for working capital.

(Added: Chapter 500, Statutes of 1996)

21080.33. Emergency Repairs

This division does not apply to any emergency project undertaken, carried out, or approved by a public agency to maintain, repair, or restore an existing highway, as defined in Section 360 of the Vehicle Code, except for a highway designated as an official state scenic highway pursuant to Section 262 of the Streets and Highways Code, within the existing right-of-way of the highway, damaged as a result of fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide, within one year of the damage. This section does not exempt from this division any project undertaken, carried out, or approved by a public agency to expand or widen a highway damaged by fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide.

(Added: Chapter 825, Statutes of 1996)

21081. Findings

Pursuant to the policy stated in Sections 21002 and 21002.1, no public agency shall approve or carry out a project for which an environmental impact report has been certified which identifies one or more significant effects on the environment that would occur if the project is approved or carried out unless both of the following occur:

(a) The public agency makes one or more of the following findings with respect to each significant effect:

(1) Changes or alterations have been required in, or incorporated into, the project which mitigate or avoid the significant effects on the environment.


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(2) Those changes or alterations are within the responsibility and jurisdiction of another public agency and have been, or can and should be, adopted by that other agency.

(3) Specific economic, legal, social, technological, other considerations, including considerations for the provision of employment opportunities for highly trained workers, make infeasible the mitigation measures or alternatives identified in the environmental impact report.

(b) With respect to significant effects which were subject to a finding under paragraph (3) of subdivision (a), the public agency finds that specific overriding economic, legal, social, technological, or other benefits of the project outweigh the significant effects on the environment.

(Amended: Chapter 1294, Statutes of 1994; Chapter 1131, Statutes of 1993)

21081.5. Basis for Findings

In making the findings required by paragraph (3) of subdivision (a) of Section 21081, the public agency shall base its findings on substantial evidence in the record.

(Amended: Chapter 1294, Statutes of 1994)

21081.6. Reporting or Monitoring

(a) When making the findings required by paragraph (1) of subdivision (a) of Section 21081 or when adopting a mitigated negative declaration pursuant to paragraph (2) of subdivision (c) of Section 21080, the following requirements shall apply:

(1) The public agency shall adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment. The reporting or monitoring program shall be designed to ensure compliance during project implementation. For those changes which have been required or incorporated into the project at the request of a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project, that agency shall, if so requested by the lead agency or a responsible agency, prepare and submit a proposed reporting or monitoring program.

(2) The lead agency shall specify the location and custodian of documents or other material which constitute the record of proceedings upon which its decision is based.

(b) A public agency shall provide that measures to mitigate or avoid significant effects on the environment are fully enforceable through permit conditions, agreements, or other measures. Conditions of project approval may be set forth in referenced documents which address required mitigation measures or, in the case of the adoption of a plan, policy, regulation, or other public project, by incorporating the mitigation measures into the plan, policy, regulation, or project design.

(c) Prior to the close of the public review period for a draft environmental impact report

or mitigated negative declaration, a responsible agency, or a public agency having
jurisdiction over natural resources affected by the project, shall either submit to the lead
agency complete and detailed performance objectives for mitigation measures which
would address the significant effects on the environment identified by the responsible
agency or agency having jurisdiction over natural resources affected by the project, or
refer the lead agency to appropriate, readily available guidelines or reference documents.
Any mitigation measures submitted to a lead agency by a responsible agency or agency
having jurisdiction over natural resources affected by the project shall be limited to
measures which mitigate impacts to resources which are subject to the statutory
authority of, and definitions applicable to, that agency. Compliance or noncompliance by
a responsible agency or agency having jurisdiction over natural resources affected by the
project with that requirement shall not limit the authority of the responsible agency or
agency having jurisdiction over natural resources affected by the project, or the
authority of the lead agency, to approve, condition, or deny projects as provided by this
division or any other provision of law.

(Amended: Chapter 1294, Statutes of 1994; Chapter 1230, Statutes of 1994; Chapter
1130, Statutes of 1993; Chapter 1070, Statutes of 1992)

21081.7. Transportation Information

Transportation information resulting from the reporting or monitoring program required
to be adopted by a public agency pursuant to Section 21081.6 shall be submitted to the
transportation planning agency in the region where the project is located and to the
Department of Transportation when the project has impacts that are of statewide,
regional, or areawide significance according to criteria developed pursuant to Section
21083. The transportation planning agency and the Department of Transportation shall
adopt guidelines for the submittal of those reporting or monitoring programs.

(Amended: Chapter 626, Statutes of 1989; Amended: Chapter 738, Statutes of 2000)

21082. Public Agency Implementation

All public agencies shall adopt by ordinance, resolution, rule or regulation, objectives,
criteria, and procedures for the evaluation of projects and the preparation of
environmental impact reports and negative declarations pursuant to this division. A
school district, or any other district, whose boundaries are coterminous with a city,
county, or city and county, may utilize the objectives, criteria, and procedures of the
city, county, or city and county, as may be applicable, in which case, the school district
or other district need not adopt objectives, criteria, and procedures of its own. The
objectives, criteria, and procedures shall be consistent with the provisions of this division
and with the guidelines adopted by the Secretary of the Resources Agency pursuant to
Section 21083. Such objectives, criteria, and procedures shall be adopted by each public
agency no later than 60 days after the Secretary of the Resources Agency has adopted
guidelines pursuant to Section 21083.

(Amended: Chapter 1312, Statutes of 1976)

21082.1. Preparation of Environmental Documents

(a) Any draft environmental impact report, environmental impact report, or negative declaration prepared pursuant to the requirements of this division shall be prepared directly by, or under contract to, a public agency.

(b) This section is not intended to prohibit, and shall not be construed as prohibiting, any person from submitting information or other comments to the public agency responsible for preparing an environmental impact report, draft environmental impact report, or negative declaration. The information or other comments may be submitted in any format, shall be considered by the public agency, and may be included, in whole or in part, in any report or declaration.

(c) The lead agency shall do all of the following:

(1) Independently review and analyze any report or declaration required by this division.

(2) Circulate draft documents which reflect its independent judgment.

(3) As part of the adoption of a negative declaration or certification of an environmental impact report, find that the report or declaration reflects the independent judgment of the lead agency.

(Amended: Chapter 1642, Statutes of 1991)

21082.2. Significant Effect on the Environment; Determination

(a) The lead agency shall determine whether a project may have a significant effect on the environment based on substantial evidence in light of the whole record.

(b) The existence of public controversy over the environmental effects of a project shall not require preparation of an environmental impact report if there is no substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment.

(c) Argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.

(d) If there is substantial evidence, in light of the whole record before the lead agency, that a project may have a significant effect on the environment, an environmental impact report shall be prepared.

(e) Statements in an environmental impact report and comments with respect to an environmental impact report shall not be deemed determinative of whether a project may have a significant effect on the environment.

(Amended: Chapter 1131, Statutes of 1993)


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21083. State Guidelines

The Office of Planning and Research shall prepare and develop proposed guidelines for the implementation of this division by public agencies. The guidelines shall include objectives and criteria for the orderly evaluation of projects and the preparation of environmental impact reports and negative declarations in a manner consistent with this division.

The guidelines shall specifically include criteria for public agencies to follow in determining whether or not a proposed project may have a "significant effect on the environment." The criteria shall require a finding that a project may have a "significant effect on the environment" if any of the following conditions exist:

(a) A proposed project has the potential to degrade the quality of the environment, curtail the range of the environment, or to achieve shortterm, to the disadvantage of longterm, environmental goals.

(b) The possible effects of a project are individually limited but cumulatively considerable. As used in this subdivision, "cumulatively considerable" means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

(c) The environmental effects of a project will cause substantial adverse effects on human beings, either directly or indirectly.

The guidelines shall also include procedures for determining the lead agency pursuant to Section 21165.

The guidelines shall also include criteria for public agencies to use in determining when a proposed project is of sufficient statewide, regional, or areawide environmental significance that it should be submitted to appropriate state agencies for review and comment prior to completion of an environmental impact report or negative declaration thereon.

The Office of Planning and Research shall develop and prepare the proposed guidelines as soon as possible and shall transmit them immediately to the Secretary of the Resources Agency. The Secretary of the Resources Agency shall certify and adopt the guidelines pursuant to Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, which shall become effective upon the filing thereof. However, the guidelines shall not be adopted without compliance with Sections 11346.4, 11346.5, and 11346.8 of the Government Code.

(Amended: Chapter 714, Statutes of 1981)

21083.1. Legislative Intent; Court Interpretations

It is the intent of the Legislature that courts, consistent with generally accepted rules of


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statutory interpretation, shall not interpret this division or the state guidelines adopted pursuant to Section 21083 in a manner which imposes procedural or substantive requirements beyond those explicitly stated in this division or in the state guidelines.

(*Added: Chapter 1070, Statutes of 1993*)

**21083.2. Significant Effect on Archaeological Resources**

(a) As part of the determination made pursuant to Section 21080.1, the lead agency shall determine whether the project may have a significant effect on archaeological resources. If the lead agency determines that the project may have a significant effect on unique archaeological resources, the environmental impact report shall address the issue of those resources. An environmental impact report, if otherwise necessary, shall not address the issue of nonunique archaeological resources. A negative declaration shall be issued with respect to a project if, but for the issue of nonunique archaeological resources, the negative declaration would be otherwise issued.

(b) If it can be demonstrated that a project will cause damage to a unique archaeological resource, the lead agency may require reasonable efforts to be made to permit any or all of these resources to be preserved in place or left in an undisturbed state. Examples of that treatment, in no order of preference, may include, but are not limited to, any of the following:

1. Planning construction to avoid archaeological sites.
2. Deeding archaeological sites into permanent conservation easements.
3. Capping or covering archaeological sites with a layer of soil before building on the sites.
4. Planning parks, greenspace, or other open space to incorporate archaeological sites.

(c) To the extent that unique archaeological resources are not preserved in place or not left in an undisturbed state, mitigation measures shall be required as provided in this subdivision. The project applicant shall provide a guarantee to the lead agency to pay one-half the estimated cost of mitigating the significant effects of the project on unique archaeological resources. In determining payment, the lead agency shall give due consideration to the inkind value of project design or expenditures that are intended to permit any or all archaeological resources or California Native American culturally significant sites to be preserved in place or left in an undisturbed state. When a final decision is made to carry out or approve the project, the lead agency shall, if necessary, reduce the specified mitigation measures to those which can be funded with the money guaranteed by the project applicant plus the money voluntarily guaranteed by any other person or persons for those mitigation purposes. In order to allow time for interested persons to provide the funding guarantee referred to in this subdivision, a final decision to carry out or approve a project shall not occur sooner than 60 days after completion of the recommended special environmental impact report required by this section.

(d) Excavation as mitigation shall be restricted to those parts of the unique


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archaeological resource that would be damaged or destroyed by the project. Excavation as mitigation shall not be required for a unique archaeological resource if the lead agency determines that testing or studies already completed have adequately recovered the scientifically consequential information from and about the resource, if this determination is documented in the environmental impact report.

(e) In no event shall the amount paid by a project applicant for mitigation measures required pursuant to subdivision (c) exceed the following amounts:

(1) An amount equal to onehalf of one percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of a commercial or industrial project.

(2) An amount equal to threefourths of one percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of a housing project consisting of a single unit.

(3) If a housing project consists of more than a single unit, an amount equal to threefourths of one percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of the project for the first unit plus the sum of the following:

(A) Two hundred dollars ($200) per unit for any of the next 99 units.

(B) One hundred fifty dollars ($150) per unit for any of the next 400 units.

(C) One hundred dollars ($100) per unit in excess of 500 units.

(f) Unless special or unusual circumstances warrant an exception, the field excavation phase of an approved mitigation plan shall be completed within 90 days after final approval necessary to implement the physical development of the project or, if a phased project, in connection with the phased portion to which the specific mitigation measures are applicable. However, the project applicant may extend that period if he or she so elects. Nothing in this section shall nullify protections for Indian cemeteries under any other provision of law.

(g) As used in this section, "unique archaeological resource" means an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

(1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.

(2) It has a special and particular quality such as being the oldest of its type or the best available example of its type.

(3) Is directly associated with a scientifically recognized important prehistoric or historic event.


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(h) As used in this section, "nonunique archaeological resource" means an archaeological artifact, object, or site which does not meet the criteria in subdivision (g). A nonunique archaeological resource need be given no further consideration, other than the simple recording of its existence by the lead agency if it so elects.

(i) As part of the objectives, criteria, and procedures required by Section 21082 or as part of conditions imposed for mitigation, a lead agency may make provisions for archaeological sites accidentally discovered during construction. These provisions may include an immediate evaluation of the find. If the find is determined to be a unique archaeological resource, contingency funding and a time allotment sufficient to allow recovering an archaeological sample or to employ one of the avoidance measures may be required under the provisions set forth in this section. Construction work may continue on other parts of the building site while archaeological mitigation takes place.

(j) This section does not apply to any project described in subdivision (a) or (b) of Section 21065 if the lead agency elects to comply with all other applicable provisions of this division. This section does not apply to any project described in subdivision (c) of Section 21065 if the applicant and the lead agency jointly elect to comply with all other applicable provisions of this division.

(k) Any additional costs to any local agency as a result of complying with this section with respect to a project of other than a public agency shall be borne by the project applicant.

(l) Nothing in this section is intended to affect or modify the requirements of Section 21084 or 21084.1.

(Amended: Chapter 375, Statutes of 1993)

21083.3. Use of a Certified EIR with Residential Development or Community Plan

(a) If a parcel has been zoned to accommodate a particular density of development or has been designated in a community plan to accommodate a particular density of development and an environmental impact report was certified for that zoning or planning action, the application of this division to the approval of any subdivision map or other project that is consistent with the zoning or community plan shall be limited to effects upon the environment which are peculiar to the parcel or to the project and which were not addressed as significant effects in the prior environmental impact report, or which substantial new information shows will be more significant than described in the prior environmental impact report.

(b) If a development project is consistent with the general plan of a local agency and an environmental impact report was certified with respect to that general plan, the application of this division to the approval of that development project shall be limited to effects upon the environment which are peculiar to the parcel or to the project and which were not addressed as significant effects in the prior environmental impact report, or which substantial new information shows will be more significant than described in


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the prior environmental impact report.

(c) Nothing in this section affects any requirement to analyze potentially significant offsite impacts and cumulative impacts of the project not discussed in the prior environmental impact report with respect to the general plan. However, all public agencies with authority to mitigate the significant effects shall undertake or require the undertaking of any feasible mitigation measures specified in the prior environmental impact report relevant to a significant effect which the project will have on the environment or, if not, then the provisions of this section shall have no application to that effect. The lead agency shall make a finding, at a public hearing, as to whether those mitigation measures will be undertaken.

(d) An effect of a project upon the environment shall not be considered peculiar to the parcel or to the project, for purposes of this section, if uniformly applied development policies or standards have been previously adopted by the city or county, with a finding based upon substantial evidence, which need not include an environmental impact report, that the development policies or standards will substantially mitigate that environmental effect when applied to future projects, unless substantial new information shows that the policies or standards will not substantially mitigate the environmental effect.

(e) Where a community plan is the basis for application of this section, any rezoning action consistent with the community plan shall be a project subject to exemption from this division in accordance with this section. As used in this section, "community plan" means a part of the general plan of a city or county which (1) applies to a defined geographic portion of the total area included in the general plan, (2) complies with Article 5 (commencing with Section 65300) of Chapter 3 of Division 1 of Title 7 of the Government Code by including or referencing each of the mandatory elements specified in Section 65302 of the Government Code, and (3) contains specific development policies adopted for the area included in the community plan and identifies measures to implement those policies, so that the policies which will apply to each parcel can be determined.

(f) No person shall have standing to bring an action or proceeding to attack, review, set aside, void, or annul a finding of a public agency made at a public hearing pursuant to subdivision (a) with respect to the conformity of the project to the mitigation measures identified in the prior environmental impact report for the zoning or planning action, unless he or she has participated in that public hearing. However, this subdivision shall not be applicable if the local agency failed to give public notice of the hearing as required by law. For purposes of this subdivision, a person has participated in the public hearing if he or she has either submitted oral or written testimony regarding the proposed determination, finding, or decision prior to close of the hearing.

(g) Any community plan adopted prior to January 1, 1982, which does not comply with the definitional criteria specified in subdivision (e) may be amended to comply with that criteria, in which case the plan shall be deemed a "community plan" within the meaning of subdivision (e) if (1) an environmental impact report was certified for adoption of the plan, and (2) at the time of the conforming amendment, the environmental impact report has not been held inadequate by a court of this state and is not the subject of pending.
litigation challenging its adequacy.

(Amended: Chapter 1102, Statutes of 1992)

21083.5. Relationship to NEPA; Tahoe Regional Planning Agency

(a) The guidelines prepared and adopted pursuant to Section 21083 shall provide that when an environmental impact statement has been, or will be, prepared for the same project pursuant to the requirements of the National Environmental Policy Act of 1969 (42 U.S.C. Section 4321 et seq.) and implementing regulations or an environmental impact report has been, or will be, prepared for the same project pursuant to the requirements of the Tahoe Regional Planning Compact (Section 66801 of the Government Code) and implementing regulations all or any part of that statement or report may be submitted in lieu of all or any part of an environmental impact report required by this division, if that statement or report, or the part which is used, complies with the requirements of this division and the guidelines adopted pursuant thereto.

(b) Notwithstanding subdivision (a), compliance with this division may be achieved for the adoption in a city or county general plan, without any additions or change, of all or any part of the regional plan prepared pursuant to the Tahoe Regional Planning Compact and implementing regulations by reviewing environmental documents, prepared by the Tahoe Regional Planning Agency addressing the plan, providing an analysis pursuant to this division of any significant effect on the environment not addressed in the environmental documents, and proceeding in accordance with Section 21081. This subdivision does not exempt a city or county from complying with the public review and notice requirements of this division.

(Amended: Chapter 493, Statutes of 1988)

21083.6. Project Requiring EIR and EIS

In the event that a project requires both an environmental impact report prepared pursuant to the requirements of this division and an environmental impact statement prepared pursuant to the requirements of the National Environmental Policy Act of 1969, an applicant may request and the lead agency may waive the time limits established pursuant to Section 21100.2 or 21151.5 if it finds that additional time is required to prepare a combined environmental impact report/environmental impact statement and that the time required to prepare such a combined document would be shorter than that required to prepare each document separately.

(Added: Chapter 1200, Statutes of 1977)

21083.7. Use of EIS

(a) In the event that a project requires both an environmental impact report prepared pursuant to the requirements of this division and an environmental impact statement prepared pursuant to the requirements of the National Environmental Policy Act of 1969, the lead agency shall, whenever possible, use the environmental impact statement as such environmental impact report as provided in Section 21083.5.

http://www.oeres.ca.gov/ceqa/stat/chap2_6.html
(b) In order to implement the provisions of this section, each lead agency to which this section is applicable shall do both of the following as soon as possible:

(1) Consult with the federal agency required to prepare such environmental impact statement.

(2) Notify the federal agency required to prepare the environmental impact statement regarding any scoping meeting for the proposed project.

(Added: Chapter 1200, Statutes of 1977; Amended: Chapter 387, Statutes of 2000)

21083.8. Closure and Reuse of Military Base

(a) For the purpose of this section, the following terms have the following meaning:

(1) "Reuse plan" means an initial plan for the reuse of a military base adopted by a local government or redevelopment agency in the form of a general plan, general plan amendment, specific plan, redevelopment plan, or other planning document.

(2) "Military base" or "base" means any military base or reservation either closed or realigned by, or scheduled for closure or realignment by, the federal government.

(b) If an environmental impact statement on the closure and reuse of a military base has been prepared and filed pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. Sec. 4321 et seq.), the lead agency that is responsible for the preparation of an environmental impact report for a reuse plan for the same base may proceed in the following manner:

(1) A notice of preparation of an environmental impact report on a reuse plan shall be prepared pursuant to either Section 21080.4 or 21080.6 and shall include a description of the reuse plan and a copy of the environmental impact statement. The notice shall indicate that the lead agency intends to utilize the environmental impact statement as a draft environmental impact report and requests comments on whether, and to what extent, the environmental impact statement provides adequate information to serve as a draft environmental impact report, and what specific additional information, if any, is necessary to comply with this division. The notice shall also indicate the address to which written comments may be sent and the deadline for submitting comments.

(2) Upon the close of the comment period on the notice of preparation, the lead agency may proceed with preparation of the environmental impact report on the reuse plan. The lead agency shall, to the greatest extent feasible, avoid duplication and utilize information in the environmental impact statement consistent with this division. The draft environmental impact report shall consist of all or part of the environmental impact statement and any additional information that is necessary to prepare a draft environmental impact report in compliance with this division.

(3) In all other respects, the environmental impact report for the reuse plan shall be completed in compliance with this division.

(c) This section shall remain in effect only until January 1, 2001, and as of that date is repealed, unless a later enacted statute, which is enacted before January 1, 2001, deletes or extends that date.

(Amended: Chapter 861, Statutes of 1995)


(a)(1) For purposes of this section, "reuse plan" for a military base or reservation has the same meaning as the term as defined in paragraph (1) of subdivision (a) of Section 21083.8, except that the reuse plan shall also consist of a statement of development policies, including a diagram or diagrams illustrating its provisions, and make the designation required in paragraph (2) of this section.

(2) The reuse plan shall designate the proposed general distribution and general location of development intensity for housing, business, industry, open space, recreation, natural resources, public buildings and grounds, roads and other transportation facilities, infrastructure, and other categories of public and private uses of land.

(b)(1) When preparing and certifying an environmental impact report for a reuse plan, including when utilizing an environmental impact statement pursuant to Section 21083.5, in addition to the procedure authorized pursuant to subdivision (b) of Section 21083.8, the determination of whether the reuse plan may have a significant effect on the environment may be made in the context of the physical conditions which were present at the time that the federal decision became final for the closure or realignment of the base or reservation. The no project alternative analyzed in the environmental impact report shall discuss the existing conditions on the base, as they exist at the time that the environmental impact report is prepared, as well as what could be reasonably expected to occur in the foreseeable future if the reuse plan were not approved, based on current plans and consistent with available infrastructure and services.

(2) For purposes of this division, all public and private activities taken pursuant to, or in furtherance of, a reuse plan shall be deemed to be a single project. However, further environmental review of any such public or private activity shall be conducted if any of the events specified in Section 21166 have occurred.

(c) Prior to preparing an environmental impact report for which a lead agency chooses to utilize the provisions of this section, the lead agency shall do all of the following:

(A) Hold a public hearing at which is discussed the federal environmental impact statement prepared for, or in the process of being prepared for, the closure of the military base or reservation. The discussion shall include the significant effects on the environment examine in the environmental impact statement, potential methods of mitigating those effects, including feasible alternatives, and the mitigative effect of federal, state, and local laws applicable to future nonmilitary activities. Prior to the close of the hearing, the lead agency may specify the baseline conditions for the reuse plan environmental impact report prepared, or in the process of being prepared, for the closure of the base or reservation. The lead agency may specify particular physical

conditions which it will examine in greater detail than were examined in the environmental impact statement. Notice of the hearing shall be given as provided in Section 21092. The hearing may be continued from time to time.

(B) Identify pertinent responsible agencies and trustee agencies and consult with those agencies prior to the public hearing as to the application of their regulatory policies and permitting standards of the proposed baseline for environmental analysis, as well as to the reuse plan and planned future nonmilitary land uses of the base or reservation. The affected agencies shall have not less than 30 days prior to the public hearing to review the proposed reuse plan and to submit their comments to the lead agency.

(C) At the close of the hearing, the lead agency shall state in writing how the lead agency intends to integrate the baseline for analysis with the reuse planning and environmental review process, taking into account the adopted environmental standards of the community, including, but not limited to, the applicable general plan, specific plan, and redevelopment plan, and including other applicable provisions of adopted congestion management plans, habitat conservation or natural communities conservation plans, integrated waste management plans, and county hazardous waste management plans.

(D) At the close of the hearing, the lead agency shall state, in writing, the specific economic or social reasons, including, but not limited to, new job creation, opportunities for employment of skilled workers, availability of low and moderate income housing, and economic continuity, which support the selection of the baseline.

(d)(1) Nothing in this section shall in any way limit the scope of a review or determination of significance of the presence of hazardous or toxic wastes, substances, or materials including, but not limited to, contaminated soils and groundwater, nor shall the regulation of hazardous or toxic wastes, substances, or materials be constrained by prior levels of activity that existed at the time that the federal agency decision to close the military base or reservation became final.

(2) This section does not apply to any project undertaken pursuant to Chapter 6.5 (commencing with Section 25100) of, or Chapter 6.8 (commencing with Section 25300) of, Division 20 of the Health and Safety Code, or pursuant to the Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000) of the Water Code).

(3) This section may apply to any reuse plan environmental impact report for which a notice of preparation pursuant to subdivision (a) of Section 21092 is issued within one year from the date that the federal record of decision was rendered for the military base or reservation closure or realignment and reuse, or prior to January 1, 1997, whichever is later, if the environmental impact report is completed and certified within five years from the date that the federal record of decision was rendered.

(e) All subsequent development at the military base or reservation shall be subject to all applicable federal, state, or local laws, including, but not limited to, those relating to air quality, water quality, traffic, threatened and endangered species, noise, and hazardous or toxic wastes, substances, or materials.


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(Added: Chapter 861, Statutes of 1995)

21083.9. EIR - Transportation Facilities

Notwithstanding Section 21080.4, 21104, or 21153, a lead agency shall call at least one scoping meeting for a proposed project which may affect highways or other facilities under the jurisdiction of the Department of Transportation if the meeting is requested by the department. The lead agency shall call the scoping meeting as soon as possible, but not later than 30 days after receiving the request from the Department of Transportation.

(Added: Chapter 532, Statutes of 1988)

21084. Categorical Exemptions; Projects Damaging Scenic Resources

(a) The guidelines prepared and adopted pursuant to Section 21083 shall include a list of classes of projects which have been determined not to have a significant effect on the environment and which shall be exempt from the provisions of this division. In adopting the guidelines, the Secretary of the Resources Agency shall make a finding that the listed classes of projects referred to in this section do not have a significant effect on the environment.

(b) No project which may result in damage to scenic resources, including, but not limited to, trees, historic buildings, rock outcroppings, or similar resources, within a highway designated as an official state scenic highway, pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 of the Streets and Highways Code, shall be exempted from this division pursuant to subdivision (a). This subdivision does not apply to improvements as mitigation for a project for which a negative declaration has been approved or an environmental impact report has been certified.

(c) No project located on a site which is included on any list compiled pursuant to Section 65962.5 of the Government Code shall be exempted from this division pursuant to subdivision (a).

(d) The changes made to this section by Chapter 1212 of the Statutes of 1991 apply only to projects for which applications have not been deemed complete on or before January 1, 1992, pursuant to Section 65943 of the Government Code.

(c) No project that may cause a substantial adverse change in the significance of an historical resource, as specified in Section 21084.1, shall be exempted from this division pursuant to subdivision (a).

(Amended: Chapter 1075, Statutes of 1992)

21084.1. Effects on Historical Resources

A project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment. For purposes of the guidelines, a historical resource is defined as an object, site, structure, or landscape that reflects, is associated with, or has significance to the historical or cultural heritage of the United States or the State of California.
of this section, an historical resource is a resource listed in, or determined to be eligible for listing in, the California Register of Historical Resources. Historical resources included in a local register of historical resources, as defined in subdivision (k) of Section 5020.1, or deemed significant pursuant to criteria set forth in subdivision (g) of Section 5024.1, are presumed to be historically or culturally significant for purposes of this section, unless the preponderance of the evidence demonstrates that the resource is not historically or culturally significant. The fact that a resource is not listed in, or determined to be eligible for listing in, the California Register of Historical Resources, not included in a local register of historical resources, or not deemed significant pursuant to criteria set forth in subdivision (g) of Section 5024.1 shall not preclude a lead agency from determining whether the resource may be an historical resource for purposes of this section.

(Added: Chapter 1075, Statutes of 1992)

21084.2. Steam Sterilization

The Office of Planning and Research shall, at the next revision of the California Environmental Quality Act Guidelines (Chapter 3 (commencing with Section 15000) of Division 6 of Title 14 of the California Code of Regulations) which takes place after January 1, 1996, pursuant to Section 21087, recommend changes to those guidelines that would determine if Sections 15301, 15302, and 15304 of Title 14 of the California Code of Regulations apply to the treatment of medical waste by steam sterilization. If the office determines that those provisions of the guidelines apply, consistent with existing law, to that treatment, the office shall recommend clarifying revisions to the guidelines to expressly state that the treatment is subject to a categorical exemption under those provisions of the guidelines. If the office determines that those provisions of the guidelines do not categorically exempt that treatment, and if such an exemption is consistent with existing law, the office shall recommend a categorical exemption for the treatment in its recommended revision of the guidelines.

(Added: Chapter 877, Statutes of 1995)

21085. Projects Including Housing Development

With respect to a project which includes housing development, a public agency shall not, pursuant to this division, reduce the proposed number of housing units as a mitigation measure or project alternative for a particular significant effect on the environment if it determines that there is another feasible specific mitigation measure or project alternative that would provide a comparable level of mitigation. This section shall not affect any other requirement regarding the residential density of that project.

(Added: Chapter 1375, Statutes of 1982)

21085.5. (Repealed: Chapter 697, Statutes of 1979)

21085.6. (Repealed: Chapter 697, Statutes of 1979)

21085.7. Aipport Projects at Specified Aiport; Environmental Impact


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Reports; Mitigation Measures Relating to Salt Ponds

(a) (1) If an environmental impact report for a project at an airport that is owned by a city and county and that is located in another county identifies as a proposed mitigation measure the acquisition, enhancement, and restoration of salt ponds and the lead agency proposes the payment of funds to one or more public agencies to mitigate the impacts of the proposed project and the public agency or agencies propose to use those funds to acquire, enhance, and restore land, the lead agency shall include in the environmental impact report on the proposed project a detailed statement of the mitigation measure, including all of the following:

(A) An analysis of the relationship between the impacts of the proposed project and the benefits of the proposed acquisition, enhancement, and restoration of land that the payment of funds would allow.

(B) An analysis of the feasibility of the proposed acquisition, enhancement, and restoration.

(C) A discussion of the expected impacts of the proposed acquisition, enhancement, and restoration.

(2) The detailed statement of the mitigation measure shall consist of the following:

(A) Information in existence at the time the environmental impact report is prepared, including the restoration goals specific to salt ponds as identified in the San Francisco Estuary Baylands Ecosystem Goals Report published in 1999.

(B) Information that is reasonably obtainable, including, but not limited to, a hydrodynamic analysis of potential flood impacts, and analyses regarding the potential for the following:

(i) Changes to the waters and tidal currents of the southern portions of the San Francisco Bay.

(ii) Potential alterations to the San Francisco Bay floor.

(iii) Related impacts on water quality.

(3) If, at the time of the publication of the draft environmental impact report, a restoration plan has not been adopted by a public agency with jurisdiction to carry out the restoration project, the lead agency for the airport project need not prepare a detailed restoration plan or analyze the impacts of a restoration plan for the lands proposed for acquisition, enhancement, and restoration; however, the lead agency shall evaluate a conceptual restoration plan, and shall fully evaluate a potentially feasible alternate mitigation measure that does not depend on salt ponds.

(b) If the lead agency for the airport project approves the proposed project and approves the payment of funds for the acquisition, enhancement, and restoration of land as a mitigation measure, it shall make both such approvals contingent upon an agreement.


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between the lead agency and the public agency or agencies wherein the public agency or agencies agree to use the funds solely for the following purposes:

(1) The acquisition, enhancement, and restoration of the lands identified by the lead agency in its detailed statement of the mitigation measure.

(2) The preparation and implementation of a restoration plan that, at a minimum, mitigates the significant impact that would be substantially lessened or avoided by implementation of the mitigation measure as identified in the final environmental impact report certified by the lead agency.

(c) The agreement described in subdivision (b) shall identify a feasible alternative mitigation measure to be implemented if the restoration of all or a portion of the salt ponds proves to be infeasible, as determined by the lead agency.

(d) Nothing in this section shall be interpreted to assess or assign liability with respect to the salt ponds.

(e) Funds for the costs of mitigation shall include the costs of the environmental reviews conducted by a state agency of the restoration plan prepared by a state agency.

(f) This section shall only apply to the acquisition, enhancement, and restoration of salt ponds located in the southerly portion of San Francisco Bay.

(g) As used in this section, "acquisition, enhancement, and restoration" also includes acquisition, enhancement, or restoration.

(h) This section shall remain in effect only until January 1, 2008, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2008, deletes or extends that date.

(Added: Chapter 925, Statutes of 2000)

21086. Addition or Deletion of Exempt Categories

A public agency may, at any time, request the addition or deletion of a class of projects, to the list designated pursuant to Section 21084. Such a request shall be made in writing to the Office of Planning and Research and shall include information supporting the public agency's position that such class of projects does, or does not, have a significant effect on the environment.

The Office of Planning and Research shall review each such request and, as soon as possible, shall submit its recommendation to the Secretary of the Resources Agency. Following the receipt of such recommendation, the Secretary of the Resources Agency may add or delete the class of projects to the list of classes of projects designated pursuant to Section 21084 which are exempt from the requirements of this division.

The addition or deletion of a class of projects, as provided in this section, to the list specified in Section 21084 shall constitute an amendment to the guidelines adopted http://www.ceres.ca.gov/ceqa/stat/chap2_6.html 9/10/2001
pursuant to Section 21083 and shall be adopted in the manner prescribed in Sections 21083, 21084, and 21087.

21087. Review of Guidelines

(a) The Office of Planning and Research shall, at least once every two years, review the guidelines adopted pursuant to Section 21083 and shall recommend proposed changes or amendments to the Secretary of the Resources Agency. The Secretary of the Resources Agency shall certify and adopt guidelines, and any amendments thereto, at least once every two years, pursuant to Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, which shall become effective upon the filing thereof. However, guidelines shall not be adopted or amended without compliance with Sections 11346.4, 11346.5, and 11346.8 of the Government Code.

(b) Within six months of enactment of AB 314 of the 1993-94 Regular Session of the Legislature, the Office of Planning and Research shall recommend proposed changes and the Secretary of the Resources Agency shall certify and adopt revisions to the guidelines pursuant to Section 21083 to reflect the changes to this division enacted during the 1993-94 Regular Session of the Legislature.

(Amended: Chapter 1294, Statutes of 1994; Chapter 1130, Statutes of 1993)

21087.5. (Repealed: Chapter 1130, Statutes of 1993)

21088. EIR Monitor

The Secretary of the Resources Agency shall provide for the timely distribution to all public agencies of the guidelines and any amendments or changes thereto. In addition, the Secretary of the Resources Agency may provide for publication of a bulletin to provide public notice of the guidelines, or any amendments or changes thereto, and of the completion of environmental impact reports prepared in compliance with this division.

21089. Fees

(a) A lead agency may charge and collect a reasonable fee from any person proposing a project subject to the provisions of this division in order to recover the estimated costs incurred by the lead agency in preparing a negative declaration or an environmental impact report for the project and for procedures necessary to comply with this division on the project. Litigation expenses, costs, and fees incurred in actions alleging noncompliance with this division on the project. Litigation expenses, costs, and fees incurred in actions alleging noncompliance with this division under Section 21167 are not recoverable under this section.

(b) The Department of Fish and Game may charge and collect filing fees, as provided in Section 711.4 of the Fish and Game Code. Notwithstanding Section 21080.1, a finding required under Section 21081, or any project approved under a certified regulatory program authorized pursuant to Section 21080.5 is not operative, vested, or final until the filing fees required pursuant to Section 711.4 of the Fish and Game Code are paid.


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Amended: Chapter 1201, Statutes of 1992

21090. Redevelopment Plans

For all purposes of this division, all public and private activities and undertakings pursuant to, or in furtherance of, a redevelopment plan shall be deemed to be a single project. However, further environmental review of any public or private activity or undertaking pursuant to, or in furtherance of, a redevelopment plan shall be conducted if any of the events specified in Section 21166 have occurred.

Amended: Chapter 1130, Statutes of 1993

21090.1. Geothermal Exploratory Projects

For all purposes of this division, a geothermal exploratory project shall be deemed to be separate and distinct from any subsequent geothermal field development project as defined in Section 65928.5 of the Government Code.

Added: Chapter 1271, Statutes of 1978

21091. Review Periods - DEIR and Negative Declarations

(a) The public review period for a draft environmental impact report shall not be less than 30 days. If the draft environmental impact report is submitted to the State Clearinghouse for review, the review period shall be at least 45 days.

(b) The public review period for a proposed negative declaration shall not be less than 20 days. If the proposed negative declaration is submitted to the State Clearinghouse for review, the review period shall be at least 30 days.

(c) Notwithstanding subdivisions (a) and (b), if a draft environmental impact report or a proposed negative declaration is submitted to the State Clearinghouse for review and the period of review by the State Clearinghouse is longer than the public review period established pursuant to subdivision (a) or (b), whichever is applicable, the public review period shall be at least as long as the period of review by the State Clearinghouse.

(d)(1) The lead agency shall consider any comments it receives on a draft environmental impact report or on a proposed negative declaration, which are received within the public review period.

(2)(A) With respect to the consideration of comments received on a draft environmental impact report, the lead agency shall evaluate any comments on environmental issues that are received from persons who have reviewed the draft and shall prepare a written response pursuant to subparagraph (B). The lead agency may also respond to comments that are received after the close of the public review period.

(B) The written response shall describe the disposition of any significant environmental issue that is raised by commenters. The responses shall be prepared consistent with http://www.ceres.ca.gov/ceqa/stat/chap2_6.html

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Section 15088 of Title 14 of the California Code of Regulations, as those regulations existed on June 1, 1993.

(e)(1) Criteria for shorter review periods by the State Clearinghouse for documents which must be submitted to the State Clearinghouse shall be set forth in the written guidelines issued by the Office of Planning and Research and made available to the public.

(2) Those shortened review periods shall not be less than 30 days for a draft environmental impact report and 20 days for a negative declaration.

(3) Any request for a shortened review period shall only be made in writing by the decisionmaking body of the lead agency to the Office of Planning and Research. The decisionmaking body may designate by resolution or ordinance a person authorized to request a shortened review period. Any designated person shall notify the decisionmaking body of this request.

(4) Any request approved by the State Clearinghouse shall be consistent with the criteria set forth in the written guidelines of the Office of Planning and Research.

(5) A shortened review period shall not be approved by the Office of Planning and Research for any proposed project of statewide, regional, or areawide environmental significance as determined pursuant to Section 21083.

(6) Any approval of a shortened review period shall be given prior to, and reflected in, the public notice required pursuant to Section 21092.

(f) Prior to carrying out or approving a project for which a negative declaration has been adopted, the lead agency shall consider the negative declaration together with any comments that were received and considered pursuant to paragraph (1) of subdivision (d).

(Amended: Chapter 1130, Statutes of 1993)

21092. Public Notice

(a) Any lead agency which is preparing an environmental impact report or a negative declaration or making a determination pursuant to Section 21157 shall provide public notice of that fact within a reasonable period of time prior to certification of the environmental impact report or adoption of the negative declaration.

(b)(1) The notice shall specify the period during which comments will be received on the draft environmental impact report or negative declaration, and shall include the date, time, and place of any public meetings or hearings on the proposed project, a brief description of the proposed project and its location, the significant effects on the environment, if any, anticipated as a result of the project, and the address where copies of the draft environmental impact report or negative declaration, and all documents referenced in the draft environmental impact report or negative declaration, are available for review.


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(2) This section shall not be construed in any manner which results in the invalidation of an action because of the alleged inadequacy of the notice content, provided that there has been substantial compliance with the notice content requirements of this section.

(3) The notice required by this section shall be given to the last known name and address of all organizations and individuals who have previously requested notice and shall also be given by at least one of the following procedures:

(A) Publication, no fewer times than required by Section 6061 of the Government Code, by the public agency in a newspaper of general circulation in the area affected by the proposed project. If more than one area will be affected, the notice shall be published in the newspaper of largest circulation from among the newspapers of general circulation in those areas.

(B) Posting of notice by the lead agency on- and off-site in the area where the project is to be located.

(C) Direct mailing to the owners and occupants of contiguous property shown on the latest equalized assessment roll.

(c) For any project involving the burning of municipal wastes, hazardous waste, or refuse-derived fuel, including, but not limited to, tires, meeting the qualifications of subdivision (d), notice shall be given to all organizations and individuals who have previously requested notice and shall also be given by at least the procedures specified in subparagraphs (A), (B), and (C) of paragraph (3) of subdivision (b). In addition, notification shall be given by direct mailing to the owners and occupants of property within one-fourth of a mile of any parcel or parcels on which is located a project subject to this subdivision. This subdivision does not apply to any project for which notice has already been provided as of July 14, 1989, in compliance with this section as it existed prior to July 14, 1989.

(d) The notice requirements of subdivision (c) apply to both of the following:

(1) The construction of a new facility.

(2) The expansion of an existing facility which burns hazardous waste which would increase its permitted capacity by more than 10 percent. For purposes of this paragraph, the amount of expansion of an existing facility shall be calculated by comparing the proposed facility capacity with whichever of the following is applicable:

(A) The facility capacity approved in the facility's hazardous waste facilities permit pursuant to Section 25200 of the Health and Safety Code or its grant of interim status pursuant to Section 25200.5 of the Health and Safety Code, or the facility capacity authorized in any state or local agency permit allowing the construction or operation of a facility for the burning of hazardous waste, granted before January 1, 1990.

(B) The facility capacity authorized in the facility's original hazardous waste facilities permit, grant of interim status, or any state or local agency permit allowing the


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construction or operation of a facility for the burning of hazardous waste, granted on or after January 1, 1990.

(e) The notice requirements specified in subdivision (b) or (c) shall not preclude a public agency from providing additional notice by other means if the agency so desires, or from providing the public notice required by this section at the same time and in the same manner as public notice otherwise required by law for the project.

(Amended: Chapter 1130, Statutes of 1993)

21092.1. Addition - Notice and Consultation

When significant new information is added to an environmental impact report after notice has been given pursuant to Section 21092 and consultation has occurred pursuant to Sections 21104 and 21153, but prior to certification, the public agency shall give notice again pursuant to Section 21092, and consult again pursuant to Sections 21104 and 21153 before certifying the environmental impact report.

(Added: Chapter 1514, Statutes of 1984.)

21092.2. Public Notice Requests

The notices required pursuant to Sections 21080.4, 21092, 21108, and 21152 shall be mailed to any person who has filed a written request for notices with either the clerk of the governing body or, if there is no governing body, the director of the agency. The request may also be filed with any other person designated by the governing body or director to receive these requests. The agency may require requests for notices to be annually renewed. The public agency may charge a fee, except to other public agencies, which is reasonable related to the costs of providing this service. This section shall not be construed in any manner which results in the invalidation of an action because of the failure of a person to receive a requested notice, provided that there has been substantial compliance with the requirements of this section.

(Added: Chapter 907, Statutes of 1989)

21092.3. Posting Requirements

The notices required pursuant to Sections 21080.4 and 21092 for an environmental impact report shall be posted in the office of the county clerk of each county in which the project will be located and shall remain posted for a period of 30 days. The notice required pursuant to Section 21092 for a negative declaration shall be so posted for a period of 20 days, unless otherwise required by law to be posted for 30 days. The county clerk shall post the notices within 24 hours of receipt.

(Amended: Chapter 1130, Statutes of 1993)

21092.4. Consultation - Public Agencies, Transportation Planning Agencies


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(a) For a project of statewide, regional, or areawide significance, the lead agency shall consult with transportation planning agencies and public agencies which have transportation facilities within their jurisdictions which could be affected by the project. Consultation shall be conducted in the same manner as for responsible agencies pursuant to this division, and shall be for the purpose of the lead agency obtaining information concerning the project's effect on major local arterials, public transit, freeways, highways, and rail transit service within the jurisdiction of a transportation planning agency or a public agency which is consulted by the lead agency. A transportation planning agency or public agency which provides information to the lead agency shall be notified of, and provided with copies of, environmental documents pertaining to the project.

(b) As used in this section "transportation facilities: includes major local arterials and public transit within five miles of the project site and freeways, highways, and rail transit service within 10 miles of the project site.

(Added: Chapter 626, Statutes 1989)

21092.5. Response to Comments

(a) At least 10 days prior to certifying an environmental impact report, the lead agency shall provide a written proposed response to a public agency on comments made by that agency which conform with the requirements of this division. Proposed responses shall conform with the legal standards established for responses to comments on draft environmental impact reports. Copies of responses or the environmental document in which they are contained, prepared in conformance with other requirements of this division and the guidelines adopted pursuant to Section 21083, may be used to meet the requirements imposed by this section.

(b) The lead agency shall notify any public agency which comments on a negative declaration, of the public hearing or hearings, if any, on the project for which the negative declaration was prepared. If notice to the commenting public agency is provided pursuant to Section 21092, the notice shall satisfy the requirement of this subdivision.

(c) Nothing in this section requires the lead agency to respond to comments not received within the comment periods specified in this division, to reopen comment periods, or to delay acting on a negative declaration or environmental impact report.

The amendments to Section 21082.1 of the Public Resources Code made by this act, and the provisions of Section 21082.5 of the Public Resources Code, apply only to projects for which notice has not been provided pursuant to Section 21092 of the Public Resources Code as of January 1, 1992.

(Added: Chapter 1642, Statutes of 1991)

21092.6. Location of Projects on Hazardous Waste Sites List

(a) The lead agency shall consult the lists compiled pursuant to Section 65962.5 of the Government Code to determine whether the project and any alternatives are located on a site which is included on any list. The lead agency shall indicate whether a site is on any list not already identified by the applicant. The lead agency shall specify the list and include the information in the statement required pursuant to subdivision (f) of Section 65962.5 of the Government Code, in the notice required pursuant to Section 21080.4, a negative declaration, and a draft environmental impact report. The requirement in this section to specify any list shall not be construed to limit compliance with this division.

(b) If a project or any alternatives are located on a site which is included on any of the lists compiled pursuant to Section 65962.5 of the Government Code and the lead agency did not accurately specify or did not specify any list pursuant to subdivision (a), the California Environmental Protection Agency shall notify the lead agency specifying any list with the site when it receives notice pursuant to Section 21080.4, a negative declaration, and a draft environmental impact report. The California Environmental Protection Agency shall not be liable for failure to notify the lead agency pursuant to this subdivision.

(c) This section applies only to projects for which applications have not been deemed complete pursuant to Section 65943 of the Government Code on or before January 1, 1992.

(Added: Chapter 1212, Statutes of 1991)

21093. Public Agencies May Tier EIRs

(a) The Legislature finds and declares that tiering of environmental impact reports will promote construction of needed housing and other development projects by (1) streamlining regulatory procedures, (2) avoiding repetitive discussions of the same issues in successive environmental impact reports, and (3) ensuring that environmental impact reports prepared for later projects which are consistent with a previously approved policy, plan, program, or ordinance concentrate upon environmental effects which may be mitigated or avoided in connection with the decision on each later project. The Legislature further finds and declares that tiering is appropriate when it helps a public agency to focus upon the issues ripe for decision at each level of environmental effects examined in previous environmental impact reports.

(b) To achieve this purpose, environmental impact reports shall be tiered whenever feasible, as determined by the lead agency.

(Amended: Chapter 418, Statutes of 1985)

21094. Later Projects

(a) Where a prior environmental impact report has been prepared and certified for a program, plan, policy, or ordinance, the lead agency for a later project that meets the requirements of this section shall examine significant effects of the later project upon the environment by using a tiered environmental impact report, except that the report on the


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later project need not examine those effects which the lead agency determines were either (1) mitigated or avoided pursuant to paragraph (1) of subdivision (a) of Section 21081 as a result of the prior environmental impact report, or (2) examined at a sufficient level of detail in the prior environmental impact report to enable those effects to be mitigated or avoided by site specific revisions, the imposition of conditions, or by other means in connection with the approval of the later project.

(b) This section applies only to a later project which the lead agency determines (1) is consistent with the program, plan, policy, or ordinance for which an environmental impact report has been prepared and certified, (2) is consistent with applicable local land use plans and zoning of the city, county, or city and county in which the later project would be located, and (3) is not subject to Section 21166.

(c) For purposes of compliance with this section, an initial study shall be prepared to assist the lead agency in making the determinations required by this section. The initial study shall analyze whether the later project may cause significant effects on the environment that were not examined in the prior environmental impact report.

(d) All public agencies which propose to carry out or approve the later project may utilize the prior environmental impact report and the environmental impact report on the later project to fulfill the requirements of Section 21081.

(e) When tiering is used pursuant to this section, an environmental impact report prepared for a later project shall refer to the prior environmental impact report and state where a copy of the prior environmental impact report may be examined.

(As amended: Chapter 418, Statutes of 1985)

21095. LESA Model; Optional Methodology

(a) The Resources Agency, in consultation with the Office of Planning and Research, shall develop an amendment to Appendix G of the state guidelines, for adoption pursuant to Section 21083, to provide lead agencies an optional methodology to ensure that significant effects on the environment of agricultural land conversions are quantitatively and consistently considered in the environmental review process.

(b) The Department of Conservation, in consultation with the United States Department of Agriculture pursuant to Section 658.6 of Title 7 of the Code of Federal Regulations, and in consultation with the Resources Agency and the Office of Planning and Research, shall develop a state model land evaluation and site assessment system, contingent upon the availability of funding from non-General Fund sources. The department shall seek funding for that purpose from non-General Fund sources, including, but not limited to, the United States Department of Agriculture.

(c) In lieu of developing an amendment to Appendix G of the state guidelines pursuant to subdivision (a), the Resources Agency may adopt the state model land evaluation and site assessment system developed pursuant to subdivision (b) as that amendment to Appendix G.
21096. Airport-Related Safety Hazards and Noise Patterns

(a) If a lead agency prepares an environmental impact report for a project situated within airport comprehensive land use plan boundaries, or, if a comprehensive land use plan has not been adopted, for a project within two nautical miles of a public airport or public use airport, the Airport Land Use Planning Handbook published by the Division of Aeronautics of the Department of Transportation, in compliance with Section 21674.5 of the Public Utilities Code and other documents, shall be utilized as technical resources to assist in the preparation of the environmental impact report as the report relates to airport-related safety hazards and noise problems.

(b) A lead agency shall not adopt a negative declaration for a project described in subdivision (a) unless the lead agency considers whether the project will result in a safety hazard or noise problem for persons using the airport or for persons residing or working in the project area.

(Added: Chapter 438, Statutes of 1994)
Chapter 4.5. Streamlined Environmental Review

(Added: Chapter 1130, Statutes of 1993)

Sections 21156 to 21159.9

Article 2

MASTER ENVIRONMENTAL IMPACT REPORT

21157. Use; Content; Fee Program

(a) A master environmental impact report may be prepared for any one of the following projects:

(1) A general plan, element, general plan amendment, or specific plan.

(2) A project that consists of smaller individual projects which will be carried out in phases.

(3) A rule or regulation which will be implemented by subsequent projects.

(4) Projects which will be carried out or approved pursuant to a development agreement.

(5) Public or private projects which will be carried out or approved pursuant to, or in furtherance of, a redevelopment plan.

(6) A state highway project or mass transit project which will be subject to multiple stages of review or approval.

(7) A regional transportation plan or congestion management plan

(8) A plan proposed by a local agency for the reuse of a federal military base or reservation that has been closed or that is proposed for closure.

(9) Regulations adopted by the Fish and Game Commission for the regulation of hunting and fishing.

(b) When a lead agency prepares a master environmental impact report, the document shall include all of the following:

(1) A detailed statement as required by Section 21100.
(2) A description of anticipated subsequent projects that would be within the scope of the master environmental impact report, that contains sufficient information with regard to the kind, size, intensity, and location of the subsequent projects, including, but not limited to, all of the following:

(A) The specific type of project anticipated to be undertaken.

(B) The maximum and minimum intensity of any anticipated subsequent project, such as the number of residences in a residential development, and, with regard to a public works facility, its anticipated capacity and service area.

(C) The anticipated location and alternative locations for any development projects.

(D) A capital outlay or capital improvement program, or other scheduling or implementing device that governs the submission and approval of subsequent projects.

(3) A description of potential impacts of anticipated subsequent projects for which there is not sufficient information reasonably available to support a full assessment of potential impacts in the master environmental impact report. This description shall not be construed as a limitation on the impacts which may be considered in a focused environmental impact report.

(c) Lead agencies may develop and implement a fee program in accordance with applicable provisions of law to generate the revenue necessary to prepare a master environmental impact report.


21157.1. Review of Subsequent Projects

The preparation and certification of a master environmental impact report, if prepared and certified consistent with this division, may allow for the limited review of subsequent projects that were described in the master environmental impact report as being within the scope of the report, in accordance with the following requirements:

(a) The lead agency for the subsequent project shall be the lead agency or any responsible agency identified in the master environmental impact report.

(b) The lead agency shall prepare an initial study on any proposed subsequent project. This initial study shall analyze whether the subsequent project may cause any significant effect on the environment that was not examined in the master environmental impact report and whether the subsequent project was described in the master environmental impact report as being within the scope of the project.

(c) If the lead agency, based on the initial study, determines that a proposed subsequent project will have no additional significant effect on the environment, as defined in subdivision (d) of Section 21158, that was not identified in the master environmental impact report and that no new or additional mitigation measures or
alternatives may be required, the lead agency shall make a written finding based upon the information contained in the initial study that the subsequent project is within the scope of the project covered by the master environmental impact report. No new environmental document nor findings pursuant to Section 21081 shall be required by this division. Prior to approving or carrying out the proposed subsequent project, the lead agency shall provide notice of this fact pursuant to Section 21092 and incorporate all feasible mitigation measures or feasible alternatives set forth in the master environmental impact report which are appropriate to the project. Whenever a lead agency approves or determines to carry out any subsequent project pursuant to this section, it shall file a notice pursuant to Section 21108 or 21152.

(d) Where a lead agency cannot make the findings required in subdivision (c), the lead agency shall prepare, pursuant to Section 21157.7, either a mitigated negative declaration or environmental impact report.


21157.5. Mitigated Negative Declaration

(a) A proposed mitigated negative declaration shall be prepared for any proposed subsequent project if both of the following occur:

(1) An initial study has identified potentially new or additional significant effects on the environment that were not analyzed in the master environmental impact report.

(2) Feasible mitigation measures or alternatives will be incorporated to revise the proposed subsequent project, before the negative declaration is released for public review, in order to avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment will occur.

(b) If there is substantial evidence in light of the whole record before the lead agency that the proposed subsequent project may have a significant effect on the environment and a mitigated negative declaration is not prepared, the lead agency shall prepare an environmental impact report or a focused environmental impact report pursuant to Section 21158.

(Added: Chapter 1130, Statutes of 1993)

21157.6. Limit on Use of Master Environmental Impact Report

The master environmental impact report shall not be used for the purposes of this chapter if (1) the certification of the report occurred more than five years prior to the filing of an application for the subsequent project, or (2) if the approval of a project that was not described in the report may affect the adequacy of the environmental review in the report for any subsequent project, unless the lead agency reviews the adequacy of the master environmental impact report and does either of the following:

(a) Finds that no substantial changes have occurred with respect to the circumstances under which the master environmental impact report was certified or that no new information, which was not known and could not have been known at the time that
the master environmental impact report was certified as complete, has become available.

(b) Certifies a subsequent or supplemental environmental impact report which has been either incorporated into the previously certified master environmental impact report or references any deletions, additions, or any other modifications to the previously certified master environmental impact report.


Article 5. Preliminary Review of Projects and Conduct of Initial Study

Sections 15060 to 15065

(Note: Newly revised language is underlined; deleted language is stricken through. The numbered sections have been adopted by the Secretary of Resources as part of the California Code of Regulations. The discussions after each section are provided by the Governor's Office of Planning and Research; they are not in the California Code of Regulations.)

15060. Preliminary Review

(a) A lead agency is allowed 30 days to review for completeness applications for permits or other entitlements for use. While conducting this review for completeness, the agency should be alert for environmental issues that might require preparation of an EIR or that may require additional explanation by the applicant. Accepting an application as complete does not limit the authority of the lead agency to require the applicant to submit additional information needed for environmental evaluation of the project. Requiring such additional information after the application is complete does not change the status of the application.

(b) Except as provided in Section 15111, the lead agency shall begin the formal environmental evaluation of the project after accepting an application as complete and determining that the project is subject to CEQA.

(c) Once an application is deemed complete, a lead agency must first determine whether an activity is subject to CEQA before conducting an initial study. An activity is not subject to CEQA if:

(1) The activity does not involve the exercise of discretionary powers by a public agency;

(2) The activity will not result in a direct or reasonably foreseeable indirect physical change in the environment; or

(3) The activity is not a project as defined in Section 15378.

(d) If the lead agency can determine that an EIR will be clearly required for a project, the agency may skip further initial review of the project and begin work directly on the EIR process described in Article 9, commencing with Section 15080. In the absence of an initial study, the lead agency shall still focus the EIR on the significant effects of the project and indicate briefly its reasons for determining that other effects would not be significant or potentially significant.

Authority: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080(b), 21080.2 and 21160, Public Resources Code.
Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 65944, Government Code; Section 21080.2, Public Resources Code.

Discussion: This section describes the actions required of the Lead Agency when it receives an application for a project. This section is necessary in order to save time that could otherwise be spent if the agency ignored environmental issues for the first 30 days of reviewing the application. The section is also necessary for allowing the efficiencies that result from moving directly to the preparation of an EIR where the agency can see that one will clearly be required. This avoids the time involved in the separate step of preparing an Initial Study where the Lead Agency believes it will perform the work of identifying effects as significant or non-significant while it does simultaneous work preparing the EIR.

This section also introduces the term "preliminary review" to apply to this early review of an application for completeness and for a possible exemption from CEQA. This term is needed to provide a shorthand way to referring to these early steps and to distinguish them from the more formal Initial Study process that follows preliminary review.

See Public Resources Code Section 21151.7 which provides that EIRs are required for certain projects.

Public Resources Code Section 21080.1, subdivision (b), requires the lead agency, upon the request of the project applicant, to provide for consultation with responsible and trustee agencies before the filing of an application. The consultation is to cover the range of actions, potential alternatives, mitigation measures, and any potential and significant effects on the environment of the project.

The 1998 amendment emphasizes that preliminary review is the appropriate time to determine whether the project is indeed subject to CEQA. Subsection (c) offers basic guidance in that area. Further, accepting an application as complete does not restrict the lead agency from requiring additional information as may be necessary for the environmental evaluation of the project.

15060.5. Preapplication Consultation

(a) For a potential project involving the issuance of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies, the lead agency shall, upon the request of a potential applicant and prior to the filing of a formal application, provide for consultation with the potential applicant to consider the range of actions, potential alternatives, mitigation measures, and any potential significant effects on the environment of the potential project.

(b) The lead agency may include in the consultation one or more responsible agencies, trustee agencies, and other public agencies who in the opinion of the lead agency may have an interest in the proposed project. The lead agency may consult the Office of Permit Assistance in the Trade and Commerce Agency for help in identifying interested agencies.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.1, Public Resources Code.

Discussion: This section incorporates the provisions of Public Resources Code Section 21080.1 enabling a project proponent to request a preapplication meeting with the lead agency to discuss their project. The lead agency is responsible for holding the meeting and may ask the California Office of Permit Assistance for help in identifying state and regional agencies that may be interested in the proposed project.

15061. Review for Exemption
(a) Once a lead agency has determined that an activity is a project subject to CEQA, a lead agency shall determine whether the project is exempt from CEQA.

(b) A project is exempt from CEQA if:

(1) The project is exempt by statute (see, e.g. Article 18, commencing with Section 15260).

(2) The project is exempt pursuant to a categorical exemption (see Article 19, commencing with Section 15300) and the application of that categorical exemption is not barred by one of the exceptions set forth in Section 15300.2.

(3) The activity is covered by the general rule that CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA.

(4) The project will be rejected or disapproved by a public agency. (See Section 15270(b)).

(c) Each public agency should include in its implementing procedures a listing of the projects often handled by the agency that the agency has determined to be exempt. This listing should be used in preliminary review.

(d) After determining that a project is exempt, the agency may prepare a Notice of Exemption as provided in Section 15062. Although the notice may be kept with the project application at this time, the notice shall not be filed with OPR or the county clerk until the project has been approved.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080(b), 21080.9, 21080.10, 21084, 21108(b), and 21152(b), Public Resources Code; No Oil, Inc. v. City of Los Angeles (1974) 13 Cal. 3d 68.

Discussion: This section outlines the review of a project to see if the project is exempt from CEQA. This review corresponds to the first steps of the process as shown on the flow chart in Appendix A. Reviewing a project for exempt status at this early time can avoid the expense of the CEQA process.

Subsection (b)(3) provides a short way for agencies to deal with discretionary activities which could arguably be subject to the CEQA process but which common sense provides should not be subject to the Act.

This section is based on the idea that CEQA applies jurisdictionally to activities which have the potential for causing environmental effects. Where an activity has no possibility of causing a significant effect, the activity will not be subject to CEQA. This approach has been noted with approval in a number of appellate court decisions including the State Supreme Court opinion in No Oil, Inc. v. City of Los Angeles.

Subsection (d) notes that timing and processing of the Notice of Exemption is to be compatible with the requirement in Section 15062 that the notice not be filed until after the agency has made a decision on the project. Section 15061(d) allows the Notice of Exemption to be completed during the preliminary review and to be kept with the project file during the processing of the project application. By including the notice in the file, the agency would show any people reviewing the file that CEQA had been considered, that the agency regarded the project as exempt, and that the agency would be ready to file the notice as soon as the decision was made on the project.

15062. Notice of Exemption
(a) When a public agency decides that a project is exempt from CEQA and the public agency approves or
determines to carry out the project, the agency may file a Notice of Exemption. The notice shall be filed,
if at all, after approval of the project. Such a notice shall include:

(1) A brief description of the project,

(2) A finding that the project is exempt from CEQA, including a citation to the State Guidelines section
or statute under which it is found to be exempt, and

(3) A brief statement of reasons to support the finding.

(b) A Notice of Exemption may be filled out and may accompany the project application through the
approval process. The notice shall not be filed with the county clerk or the OPR until the project has been
approved.

(c) When a public agency approves an applicant's project, either the agency or the applicant may file a
notice of exemption.

(1) When a state agency files this notice, the notice of exemption is filed with OPR. A form for this
notice is provided in Appendix E. A list of all such notices shall be posted on a weekly basis at the Office
of Planning and Research, 1400 Tenth Street, Sacramento, California. The list shall remain posted for at
least 30 days.

(2) When a local agency files this notice, the notice of exemption is filed with the county clerk of each
county in which the project will be located. Copies of all such notices shall be available for public
inspection and such notices shall be posted within 24 hours of receipt in the office of the county clerk.
Each notice shall remain posted for a period of 30 days. Thereafter, the clerk shall return the notice to the
local agency with a notation of the period it was posted. The local agency shall retain the notice for not
less than 9 months.

(3) All public agencies are encouraged to make postings pursuant to this section available in electronic
format on the Internet. Such electronic postings are in addition to the procedures required by these
guidelines and the Public Resources Code.

(4) When an applicant files this notice, special rules apply.

(A) The notice filed by an applicant is filed in the same place as if it were filed by the agency granting
the permit. If the permit was granted by a state agency, the notice is filed with OPR. If the permit was
granted by a local agency, the notice is filed with the county clerk of the county or counties in which the
project will be located.

(B) The Notice of Exemption filed by an applicant shall contain the information required in subdivision
(a) together with a certified document issued by the public agency stating that the agency has found the
project to be exempt. The certified document may be a certified copy of an existing document or record
of the public agency.

(C) A notice filed by an applicant is subject to the same posting and time requirements as a notice filed
by a public agency.

(d) The filing of a Notice of Exemption and the posting on the list of notices start a 35 day statute of
limitations period on legal challenges to the agency's decision that the project is exempt from CEQA. If a
Notice of Exemption is not filed, a 180 day statute of limitations will apply.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21108
and 21152, Public Resources Code.
Discussion: This section prescribes the use and content of the Notice of Exemption. Agencies are authorized but not required to file this notice. The regulation spells out minimum contents so that people can recognize whether a particular notice applies to the project with which they are concerned. The section notes that the effect of filing the notice is to start a short statute of limitations period. If the notice is not filed, a longer period would apply. Failure to comply with all of the requirements for filing notices of exemption results in the longer, 180-day, statute of limitations applying.

Subsection (c)(3) encourages agencies to post notices on the internet. This provides the public with an additional opportunity for notice of project decisions.

This section has been amended to conform with the statutory amendments made by Chapter 571 Statutes of 1984. The Notice of Exemption formerly filed with the Secretary of Resources is now filed with OPR. The filing and posting of notices at OPR now commences the 35 day statute of limitations period.

15063. Initial Study

(a) Following preliminary review, the Lead Agency shall conduct an Initial Study to determine if the project may have a significant effect on the environment. If the Lead Agency can determine that an EIR will clearly be required for the project, an Initial Study is not required but may still be desirable.

(1) All phases of project planning, implementation, and operation must be considered in the Initial Study of the project.

(2) To meet the requirements of this section, the lead agency may use an environmental assessment or a similar analysis prepared pursuant to the National Environmental Policy Act.

(3) An initial study may rely upon expert opinion supported by facts, technical studies or other substantial evidence to document its findings. However, an initial study is neither intended nor required to include the level of detail included in an EIR.

(b) Results.

(1) If the agency determines that there is substantial evidence that any aspect of the project, either individually or cumulatively, may cause a significant effect on the environment, regardless of whether the overall effect of the project is adverse or beneficial, the Lead Agency shall do one of the following:

(A) Prepare an EIR, or

(B) Use a previously prepared EIR which the Lead Agency determines would adequately analyze the project at hand, or

(C) Determine, pursuant to a program EIR, tiering, or another appropriate process, which of a project's effects were adequately examined by an earlier EIR or negative declaration. Another appropriate process may include, for example, a master EIR, a master environmental assessment, approval of housing and neighborhood commercial facilities in urban areas as described in section 15181, approval of residential projects pursuant to a specific plan described in section 15182, approval of residential projects consistent with a community plan, general plan or zoning as described in section 15183, or an environmental document prepared under a State certified regulatory program. The lead agency shall then ascertain which effects, if any, should be analyzed in a later EIR or negative declaration.

(2) The Lead Agency shall prepare a Negative Declaration if there is no substantial evidence that the project or any of its aspects may cause a significant effect on the environment.
(c) Purposes. The purposes of an Initial Study are to:

(1) Provide the Lead Agency with information to use as the basis for deciding whether to prepare an EIR or a Negative Declaration.

(2) Enable an applicant or Lead Agency to modify a project, mitigating adverse impacts before an EIR is prepared, thereby enabling the project to qualify for a Negative Declaration.

(3) Assist in the preparation of an EIR, if one is required, by:

(A) Focusing the EIR on the effects determined to be significant,

(B) Identifying the effects determined not to be significant,

(C) Explaining the reasons for determining that potentially significant effects would not be significant, and

(D) Identifying whether a program EIR, tiering, or another appropriate process can be used for analysis of the project's environmental effects.

(4) Facilitate environmental assessment early in the design of a project;

(5) Provide documentation of the factual basis for the finding in a Negative Declaration that a project will not have a significant effect on the environment;

(6) Eliminate unnecessary EIRs;

(7) Determine whether a previously prepared EIR could be used with the project.

(d) Contents. An Initial Study shall contain in brief form:

(1) A description of the project including the location of the project;

(2) An identification of the environmental setting;

(3) An identification of environmental effects by use of a checklist, matrix, or other method, provided that entries on a checklist or other form are briefly explained to indicate that there is some evidence to support the entries. The brief explanation may be either through a narrative or a reference to another information source such as an attached map, photographs, or an earlier EIR or negative declaration. A reference to another document should include, where appropriate, a citation to the page or pages where the information is found.

(4) A discussion of the ways to mitigate the significant effects identified, if any;

(5) An examination of whether the project would be consistent with existing zoning, plans, and other applicable land use controls;

(6) The name of the person or persons who prepared or participated in the Initial Study.

(e) Submission of Data. If the project is to be carried out by a private person or private organization, the Lead Agency may require such person or organization to submit data and information which will enable the Lead Agency to prepare the Initial Study. Any person may submit any information in any form to assist a Lead Agency in preparing an Initial Study.

(f) Format. Sample forms for an applicant's project description and a review form for use by the lead
agency are contained in Appendices G and H. When used together, these forms would meet the requirements for an initial study, provided that the entries on the checklist are briefly explained pursuant to subsection (d)(3). These forms are only suggested, and public agencies are free to devise their own format for an initial study. A previously prepared EIR may also be used as the initial study for a later project.

(g) Consultation. As soon as a Lead Agency has determined that an Initial Study will be required for the project, the Lead Agency shall consult informally with all Responsible Agencies and all Trustee Agencies responsible for resources affected by the project to obtain the recommendations of those agencies as to whether an EIR or a Negative Declaration should be prepared. During or immediately after preparation of an Initial Study for a private project, the Lead Agency may consult with the applicant to determine if the applicant is willing to modify the project to reduce or avoid the significant effects identified in the Initial Study.


Discussion: The purpose of this section is to describe the process, contents, and use of the Initial Study. This is a device not mentioned in the statute itself. The Initial Study is necessary in order to provide the factual and analytical basis for a Negative Declaration or to focus an EIR on the significant effects of a project. This section is also necessary to authorize and encourage the use of a number of efficiencies including using a Negative Declaration when the project proponent has changed his proposal in order to mitigate or avoid the significant effects identified in an Initial Study. The section also makes the point that the Initial Study can be used to determine whether a previously prepared EIR would adequately apply to the project at hand, or whether pursuant to a program EIR, tiering, or other appropriate process one or more of the project's effects were adequately examined by an earlier EIR or negative declaration. These two provisions would result, respectively, in the use of an EIR from an earlier project pursuant to section 15153 or in building upon a previous EIR or negative declaration as generally provided in section 15152, Article 11 (commencing with section 15160), or other provisions.

This section also clarifies that the individual conclusions reached by an initial study must be based on some evidence. Entries on a checklist or other form should be briefly explained to indicate the basis for determinations. These explanations are not intended to be as detailed as an EIR (Leonoff v. Monterey County Board of Supervisors (1990) 222 Cal.App.3d 1337).

Since a lead agency must consider all impacts of a project, consultation provides access to the expertise of other agencies in evaluating a project. In Sandstrom v. Mendocino (1988) 202 Cal. App. 3d 296, the court held that "some degree of interdisciplinary consultation may be necessary on an initial study as well as in preparation of an EIR." It also stated that an agency must provide the information it used to reach its conclusions and that a checklist unsupported by data and facts is not sufficient for an adequate Initial Study. In Antioch v. Pittsburg (1986) 187 Cal. App. 3d 1325, the court cited City of Carmel-by-the-Sea v. Board of Supervisors of Monterey County 183 Cal. App. 3d 229, to emphasize the importance of considering in the initial study all the activities and impacts involved in planning, implementation, and operation of a project.

15064. Determining the Significance of the Environmental Effects Caused by a Project

(a) Determining whether a project may have a significant effect plays a critical role in the CEQA process.

(1) If there is substantial evidence, in light of the whole record before a lead agency, that a project may have a significant effect on the environment, the agency shall prepare a draft EIR.
(2) When a final EIR identifies one or more significant effects, the Lead Agency and each Responsible Agency shall make a finding under Section 15091 for each significant effect and may need to make a statement of overriding considerations under Section 15093 for the project.

(b) The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting. For example, an activity which may not be significant in an urban area may be significant in a rural area.

(c) In determining whether an effect will be adverse or beneficial, the Lead Agency shall consider the views held by members of the public in all areas affected as expressed in the whole record before the lead agency. Before requiring the preparation of an EIR, the Lead Agency must still determine whether environmental change itself might be substantial.

(d) In evaluating the significance of the environmental effect of a project, the Lead Agency shall consider direct physical changes in the environment which may be caused by the project and reasonably foreseeable indirect physical changes in the environment which may be caused by the project.

(1) A direct physical change in the environment is a physical change in the environment which is caused by and immediately related to the project. Examples of direct physical changes in the environment are the dust, noise, and traffic of heavy equipment that would result from construction of a sewage treatment plant and possible odors from operation of the plant.

(2) An indirect physical change in the environment is a physical change in the environment which is not immediately related to the project, but which is caused indirectly by the project. If a direct physical change in the environment in turn causes another change in the environment, then the other change is an indirect physical change in the environment. For example, the construction of a new sewage treatment plant may facilitate population growth in the service area due to the increase in sewage treatment capacity and may lead to an increase in air pollution.

(3) An indirect physical change is to be considered only if that change is a reasonably foreseeable impact which may be caused by the project. A change which is speculative or unlikely to occur is not reasonably foreseeable.

(e) Economic and social changes resulting from a project shall not be treated as significant effects on the environment. Economic or social changes may be used, however, to determine that a physical change shall be regarded as a significant effect on the environment. Where a physical change is caused by economic or social effects of a project, the physical change may be regarded as a significant effect in the same manner as any other physical change resulting from the project. Alternatively, economic and social effects of a physical change may be used to determine that the physical change is a significant effect on the environment. If the physical change causes adverse economic or social effects on people, those adverse effects may be used as a factor in determining whether the physical change is significant. For example, if a project would cause overcrowding of a public facility and the overcrowding causes an adverse effect on people, the overcrowding would be regarded as a significant effect.

(f) The decision as to whether a project may have one or more significant effects shall be based on substantial evidence in the record of the lead agency.

(1) If the lead agency determines there is substantial evidence in the record that the project may have a significant effect on the environment, the lead agency shall prepare an EIR (Friends of B Street v. City of Hayward (1980) 106 Cal.App.3d 988). Said another way, if a lead agency is presented with a fair argument that a project may have a significant effect on the environment, the lead agency shall prepare an EIR even though it may also be presented with other substantial evidence that the project will not have
a significant effect (No Oil, Inc. v. City of Los Angeles (1974) 13 Cal.3d 68).

(2) If the lead agency determines there is substantial evidence in the record that the project may have a significant effect on the environment but the lead agency determines that revisions in the project plans or proposals made by, or agreed to by, the applicant would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur and there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment then a mitigated negative declaration shall be prepared.

(3) If the lead agency determines there is no substantial evidence that the project may have a significant effect on the environment, the lead agency shall prepare a negative declaration (Friends of B Street v. City of Hayward (1980) 106 Cal.App. 3d 988).

(4) The existence of public controversy over the environmental effects of a project will not require preparation of an EIR if there is no substantial evidence before the agency that the project may have a significant effect on the environment.

(5) Argument, speculation, unsubstantiated opinion or narrative, or evidence that is clearly inaccurate or erroneous, or evidence that is not credible, shall not constitute substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion support by facts.

(6) Evidence of economic and social impacts that do not contribute to or are not caused by physical changes in the environment is not substantial evidence that the project may have a significant effect on the environment.

(7) The provisions of sections 15162, 15163, and 15164 apply when the project being analyzed is a change to, or further approval for, a project for which an EIR or negative declaration was previously certified or adopted (e.g. a tentative subdivision, conditional use permit). Under case law, the fair argument standard does not apply to determinations of significance pursuant to sections 15162, 15163, and 15164.

(k) After application of the principles set forth above in Section 15064(f)(g), and in marginal cases where it is not clear whether there is substantial evidence that a project may have a significant effect on the environment, the lead agency shall be guided by the following principle: If there is disagreement among expert opinion supported by facts over the significance of an effect on the environment, the Lead Agency shall treat the effect as significant and shall prepare an EIR.

(h)(1)(A) Except as otherwise required by Section 15065, a change in the environment is not a significant effect if the change complies with a standard that meets the definition in subsection (h)(4)(3).

B) If there is a conflict between standards, the lead agency shall determine which standard is appropriate for purposes of this subsection based upon substantial evidence in light of the whole record.

(C) Notwithstanding subsection (h)(4)(1)(A), if the lead agency determines on the basis of substantial evidence in light of the whole record that a standard is inappropriate to determine the significance of an effect for a particular project, the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(2) In the absence of a standard that satisfies subsection (h)(4)(1)(A)(c), the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(3) For the purposes of this subsection a "standard" means a standard of general application that is all of the following:
(A) a quantitative, qualitative or performance requirement found in a statute, ordinance, resolution, rule, regulation, order, or other standard of general application;

(B) adopted for the purpose of environmental protection;

(C) adopted by a public agency through a public review process to implement, interpret, or make specific the law enforced or administered by the public agency;

(D) one that governs the same environmental effect which the change in the environment is impacting; and,

(E) one that governs within the jurisdiction where the project is located.

(4) This definition includes thresholds of significance adopted by lead agencies which meet the requirements of this subsection.

(i)(1) When assessing whether a cumulative effect requires an EIR, the lead agency shall consider whether the cumulative impact is significant and whether the effects of the project are cumulatively considerable. An EIR must be prepared if the cumulative impact may be significant and the project's incremental effect, though individually limited, is cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects. "Probable future projects" are defined in Section 15130.

(2) A lead agency may determine in an initial study that a project's contribution to a significant cumulative impact will be rendered less than cumulatively considerable and thus is not significant. When a project might contribute to a significant cumulative impact, but the contribution will be rendered less than cumulatively considerable through mitigation measures set forth in a mitigated negative declaration, the initial study shall briefly indicate and explain how the contribution has been rendered less than cumulatively considerable.

(3) A lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem (e.g., water quality control plan, air quality plan, integrated waste management plan) within the geographic area in which the project is located. Such plans or programs must be specified in law or adopted by the public agency with jurisdiction over the affected resources through a public review process to implement, interpret, or make specific the law enforced or administered by the public agency.

(4) A lead agency may determine that the incremental impacts of a project are not cumulatively considerable when they are so small that they make only a de minimis contribution to a significant cumulative impact caused by other projects that would exist in the absence of the proposed project. Such de minimus incremental impacts, by themselves, do not trigger the obligation to prepare an EIR. A de minimus contribution means that the environmental conditions would essentially be the same whether or not the proposed project is implemented.

(5) The mere existence of significant cumulative impacts caused by other projects alone shall not constitute substantial evidence that the proposed project's incremental effects are cumulatively considerable.


Discussion: This section provides general criteria to guide agencies in determining the significance of
environmental effects of their project as required by Section 21083. This section is necessary because the determination of significance is one of the key decisions in the CEQA process. This decision leads to the preparation of either a Negative Declaration or an EIR which involves the additional requirements to investigate the significant effects, to propose mitigation measures and alternatives, to respond to public comments, and to make findings on the feasibility of changing the project to reduce or avoid the significant effects. This section incorporates statutory provisions which: define "substantial evidence," specify that controversy alone, without substantial evidence of a significant effect, does not trigger the need for an EIR; limit CEQA's analysis to physical effects, except under some circumstances; and specify that determinations of significance are to be based on the whole record before the lead agency. This section also provides for the use of a mitigated negative declaration when warranted.

Regarding subsection (e), as to public controversy, the court in Antioch v. Pittsburg (1986) 187 Cal. App. 3d 1325, stated that the absence of controversy does not justify a negative declaration when there are otherwise significant impacts.

Subsection (f) is necessary for providing an interpretation of how economic and social effects can be used in determining the significance of physical changes. This interpretation is needed to resolve a number of potentially conflicting provisions in CEQA as explained in the discussion of Section 15130.

Regarding subsection (g), Public Resources Code section 21082.2 provides that the determination of significance shall be based upon substantial evidence in light of the whole record before the agency. This may include materials that are not part of the environmental document, but that are known to and have been considered by the agency. Public Resources Code section 21082.2 states that: "argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence." Substantial evidence is defined to include: "facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts." Public controversy alone, without substantial evidence of a significant effect, does not require preparation of an EIR.

Pursuant to Public Resources Code section 21084.1, a project which may result in a substantial adverse change in the significance of a historical resource may have a significant effect on the environment.

Subsection (i) promotes the use of standards and thresholds that have been adopted to protect the environment as the means for determining the significance of project impacts. Where an applicable standard or threshold exists, an environmental change which complies with that standard or threshold would not be considered significant.

"Standard" has been carefully defined to ensure that any such benchmark for determining significance has been adopted for the purpose of environmental protection, governs the same environmental effect that the project is causing, and governs within the area of the project. Further, only those standards which have been adopted by a public agency after a public review process are applicable.

Subsection (i) provides guidance for determining at an early stage whether a project will make a considerable contribution to a significant cumulative effect. When the project does not make a considerable contribution to a potentially significant cumulative effect, or if any contribution is rendered less than cumulatively considerable through mitigation, no analysis is required beyond that necessary to determine that the contribution is not considerable and a negative declaration or mitigated negative declaration is required. When the contribution is determined to be considerable, an EIR must be prepared in order to further analyze the cumulative effect.

Subsection (i) also provides that where the incremental impacts of a project are so small as to be de minimus, no EIR is required. De minimus means that the environmental conditions would essentially be the same with or without the project.

Pursuant to section 15063, this initial determination of whether the project adds a considerable
contribution does not require the extent of analysis that would be required of a discussion of cumulative impacts in an EIR.

15064.5. Determining the Significance of Impacts to Archeological and Historical Resources

(a) For purposes of this section, the term "historical resources" shall include the following:

(1) A resource listed in, or determined to be eligible by the State Historical Resources Commission, for listing in the California Register of Historical Resources (Pub. Res. Code SS5024.1, Title 14 CCR, Section 4850 et seq.).

(2) A resource included in a local register of historical resources, as defined in section 5020.1(k) of the Public Resources Code or identified as significant in an historical resource survey meeting the requirements section 5024.1(g) of the Public Resources Code, shall be presumed to be historically or culturally significant. Public agencies must treat any such resource as significant unless the preponderance of evidence demonstrates that it is not historically or culturally significant.

(3) Any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California may be considered to be an historical resource, provided the lead agency's determination is supported by substantial evidence in light of the whole record. Generally, a resource shall be considered by the lead agency to be "historically significant" if the resource meets the criteria for listing on the California Register of Historical Resources (Pub. Res. Code SS5024.1, Title 14 CCR, Section 4852) including the following:

(A) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;

(B) Is associated with the lives of persons important in our past;

(C) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or

(D) Has yielded, or may be likely to yield, information important in prehistory or history.

(4) The fact that a resource is not listed in, or determined to be eligible for listing in the California Register of Historical Resources, not included in a local register of historical resources (pursuant to section 5020.1(k) of the Public Resources Code), or identified in an historical resources survey (meeting the criteria in section 5024.1(g) of the Public Resources Code) does not preclude a lead agency from determining that the resource may be an historical resource as defined in Public Resources Code sections 5020.1(j) or 5024.1.

(b) A project with an effect that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment.

(1) Substantial adverse change in the significance of an historical resource means physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired.

(2) The significance of an historical resource is materially impaired when a project:

(A) Demolishes or materially alters in an adverse manner those physical characteristics of an historical
resource that convey its historical significance and that justify its inclusion in, or eligibility for, inclusion in the California Register of Historical Resources;

(B) Demolishes or materially alters in an adverse manner those physical characteristics that account for its inclusion in a local register of historical resources pursuant to section 5020.1(k) of the Public Resources Code or its identification in an historical resources survey meeting the requirements of section 5024.1(g) of the Public Resources Code, unless the public agency reviewing the effects of the project establishes by a preponderance of evidence that the resource is not historically or culturally significant; or

(C) Demolishes or materially alters in an adverse manner those physical characteristics of a historical resource that convey its historical significance and that justify its eligibility for inclusion in the California Register of Historical Resources as determined by a lead agency for purposes of CEQA.

(3) Generally, a project that follows the Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings or the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (1995), Weeks and Grimmer, shall be considered as mitigated to a level of less than a significant impact on the historical resource.

(4) A lead agency shall identify potentially feasible measures to mitigate significant adverse changes in the significance of an historical resource. The lead agency shall ensure that any adopted measures to mitigate or avoid significant adverse changes are fully enforceable through permit conditions, agreements, or other measures.

(5) When a project will affect state-owned historical resources, as described in Public Resources Code Section 5024, and the lead agency is a state agency, the lead agency shall consult with the State Historic Preservation Officer as provided in Public Resources Code Section 5024.5. Consultation should be coordinated in a timely fashion with the preparation of environmental documents.

(c) CEQA applies to effects on archaeological sites.

(1) When a project will impact an archaeological site, a lead agency shall first determine whether the site is an historical resource, as defined in subsection (a).

(2) If a lead agency determines that the archaeological site is an historical resource, it shall refer to the provisions of Section 21084.1 of the Public Resources Code, and this section, Section 15126.4 of the Guidelines, and the limits contained in Section 21083.2 of the Public Resources Code do not apply.

(3) If an archaeological site does not meet the criteria defined in subsection (a), but does meet the definition of a unique archaeological resource in Section 21083.2 of the Public Resources Code, the site shall be treated in accordance with the provisions of section 21083.2. The time and cost limitations described in Public Resources Code Section 21083.2 (c-f) do not apply to surveys and site evaluation activities intended to determine whether the project location contains unique archaeological resources.

(4) If an archaeological resource is neither a unique archaeological nor an historical resource, the effects of the project on those resources shall not be considered a significant effect on the environment. It shall be sufficient that both the resource and the effect on it are noted in the Initial Study or EIR, if one is prepared to address impacts on other resources, but they need not be considered further in the CEQA process.

(d) When an initial study identifies the existence of, or the probable likelihood, of Native American human remains within the project, a lead agency shall work with the appropriate native americans as identified by the Native American Heritage Commission as provided in Public Resources Code SS5097.98. The applicant may develop an agreement for treating or disposing of, with appropriate dignity, the human remains and any items associated with Native American burials with the appropriate
Native Americans as identified by the Native American Heritage Commission. Action implementing such an agreement is exempt from:

(1) The general prohibition on disinterring, disturbing, or removing human remains from any location other than a dedicated cemetery (Health and Safety Code Section 7050.5).

(2) The requirements of CEQA and the Coastal Act.

(e) In the event of accidental discovery or recognition of any human remains in any location other than a dedicated cemetery, the following steps should be taken:

(1) There shall be no further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains until:

(A) The coroner of the county in which the remains are discovered must be contacted to determine that no investigation of the cause of death is required, and

(B) If the coroner determines the remains to be Native American:

1. The coroner shall contact the Native American Heritage Commission within 24 hours.

2. The Native American Heritage Commission shall identify the person or persons it believes to be the most likely descended from the deceased native american.

3. The most likely descendent may make recommendations to the landowner or the person responsible for the excavation work, for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in Public Resources Code Section 5097.98, or

(2) Where the following conditions occur, the landowner or his authorized representative shall rebury the Native American human remains and associated grave goods with appropriate dignity on the property in a location not subject to further subsurface disturbance.

(A) The Native American Heritage Commission is unable to identify a most likely descendent or the most likely descendent failed to make a recommendation within 24 hours after being notified by the commission.

(B) The descendent identified fails to make a recommendation; or

(C) The landowner or his authorized representative rejects the recommendation of the descendent, and the mediation by the Native American Heritage Commission fails to provide measures acceptable to the landowner.

(f) As part of the objectives, criteria, and procedures required by Section 21082 of the Public Resources Code, a lead agency should make provisions for historical or unique archaeological resources accidentally discovered during construction. These provisions shall include an immediate evaluation of the find by a qualified archaeologist. If the find is determined to be an historical or unique archaeological resource, contingency funding and a time allotment sufficient to allow for implementation of avoidance measures or appropriate mitigation should be available. Work could continue on other parts of the building site while historical or unique archaeological resource mitigation takes place.


Discussion: This section establishes rules for the analysis of historical resources, including

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archaeological resources, in order to determine whether a project may have a substantial adverse effect on the significance of the resource. This incorporates provisions previously contained in Appendix K of the Guidelines. Subsection (a) relies upon the holding in League for Protection of Oakland's Architectural and Historic Resources v. City of Oakland (1997) 52 Cal.App.4th 896 to describe the relative significance of resources which are listed in the California Register of Historical Resources, listed in a local register or survey or eligible for listing, or that may be considered locally significant despite not being listed or eligible for listing. Subsection (b) describes those actions which have substantial adverse effects. Subsection (c) describes the relationship between historical resources and archaeological resources, as well as limits on the cost of mitigating impacts on unique archaeological resources. Subsections (d) and (e) discuss the protocol to be followed if Native American or other human remains are discovered.

**15064.7. Thresholds of Significance.**

(a) Each public agency is encouraged to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. A threshold of significance is an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant.

(b) Thresholds of significance to be adopted for general use as part of the lead agency's environmental review process must be adopted by ordinance, resolution, rule, or regulation, and developed through a public review process and be supported by substantial evidence.


Discussion: This section encourages agencies to develop, publish, and use thresholds of significance as a means of standardizing environmental assessments. Thresholds may constitute standards for determining significance pursuant to subsection (i) of section 15064. Note that if an agency decides to adopt thresholds it must do so by ordinance, resolution, regulation or rule at the conclusion of a public review process.

**15065. Mandatory Findings of Significance**

A lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where any of the following conditions occur:

(a) The project has the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish and wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of an endangered, rare or threatened species, or eliminate important examples of the major periods of California history or prehistory.

(b) The project has the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals.

(c) The project has possible environmental effects which are individually limited but cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects as defined in Section 15130.

(d) The environmental effects of a project will cause substantial adverse effects on human beings. either
directly or indirectly.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21001(c) and 21083, Public Resources Code; San Joaquin Raptor/Wildlife Center v. County of Stanislaus (1996) 42 Cal.App.4th 608.

Discussion: This section provides additional explanation of the mandatory findings of significance required by the Legislature in Section 21083. These mandatory findings control not only the decision of whether to prepare an EIR but also the identification of effects to be analyzed in depth in the EIR, the requirement to make detailed findings on the feasibility of alternatives or mitigation measures to reduce or avoid the significant effects, and when found to be feasible, the making of changes in the project to lessen the adverse environmental impacts. This section is necessary to insure that public agencies follow the concerns of the Legislature in determining that certain effects shall be found significant and then take the actions at the different stages of the process that are required with significant effects.

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Title 14. California Code of Regulations
Chapter 3. Guidelines for Implementation of the California Environmental Quality Act

Article 10. Considerations in Preparing EIRs and Negative Declarations

Sections 15140 to 15154

15140. Writing

EIRs shall be written in plain language and may use appropriate graphics so that decision-makers and the public can rapidly understand the documents.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003 and 21100, Public Resources Code.

Discussion: This section is intended to improve the clarity of EIRs. The section is also necessary to provide an interpretation resolving the question of who is the appropriate audience for the EIR.

15141. Page Limits

The text of draft EIRs should normally be less than 150 pages and for proposals of unusual scope or complexity should normally be less than 300 pages.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21100, Public Resources Code.

Discussion: The recommended page limits encourage agencies to reduce unneeded bulk in EIRs and to help the documents disclose the key environmental issues to the decision-makers and the public. Further, the page limits match the page limits under the federal system. Adopting the same limits as used in the federal system improves compatibility of the two systems.

15142. Interdisciplinary Approach

An EIR shall be prepared using an interdisciplinary approach which will ensure the integrated use of the natural and social sciences and the consideration of qualitative as well as quantitative factors. The interdisciplinary analysis shall be conducted by competent individuals, but no single discipline shall be designated or required to undertake this evaluation.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference Sections 21000, 21001, and 21100, Public Resources Code.

Discussion: This section is necessary to show that an EIR must use many disciplines in order to find the interrelationships among the various factors in the environmental effects. The requirement for an interdisciplinary is also part of NEPA. Accordingly, this requirement comes from the legislative history of CEQA. This section also makes the essential point that an EIR must consider qualitative


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factors as well as quantitative, economic, and technical factors.

15143. Emphasis

The EIR shall focus on the significant effects on the environment. The significant effects should be discussed with emphasis in proportion to their severity and probability of occurrence. Effects dismissed in an Initial Study as clearly insignificant and unlikely to occur need not be discussed further in the EIR unless the Lead Agency subsequently receives information inconsistent with the finding in the Initial Study. A copy of the Initial Study may be attached to the EIR to provide the basis for limiting the impacts discussed.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This section provides an interpretation that the Initial Study can be used to show which effects were examined and found to be insignificant and, therefore, not worthy of further discussion.

15144. Forecasting

Drafting an EIR or preparing a Negative Declaration necessarily involves some degree of forecasting. While foreseeing the unforeseeable is not possible, an agency must use its best efforts to find out and disclose all that it reasonably can.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This section limits the requirement for forecasting to that which could be reasonably expected under the circumstances and is part of the effort to provide a general "rule of reason" for EIR contents.

In regard to forecasting, the Laurel Heights Court commented that an agency is required to forecast only to the extent that an activity could be reasonably expected under the circumstances. An agency cannot be expected to predict the future course of governmental regulation or exactly what information scientific advances may ultimately reveal. Laurel Heights Improvement Association v. Regents of the University of California (1988) 47 Cal. 3d 376.

15145. Speculation

If, after thorough investigation, a Lead Agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact.


Discussion: This section deals with a difficulty in forecasting where a thorough investigation is unable to resolve an issue and the answer remains purely speculative. This section is necessary to relieve the Lead Agency from a requirement to engage in idle speculation. Once an agency finds that a particular effect is too speculative for evaluation, discussion of that effect should be terminated. This section provides authority to do so.

In Laurel Heights Improvement Association v. Regents of the University of California (1988) 47 Cal. 3d 376, the court noted that where future development is unspecified and uncertain, no purpose can be served by requiring an EIR to engage in sheer speculation as to future environmental consequences.

15146. Degree of Specificity


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The degree of specificity required in an EIR will correspond to the degree of specificity involved in the underlying activity which is described in the EIR.

(a) An EIR on a construction project will necessarily be more detailed in the specific effects of the project than will be an EIR on the adoption of a local general plan or comprehensive zoning ordinance because the effects of the construction can be predicted with greater accuracy.

(b) An EIR on a project such as the adoption or amendment of a comprehensive zoning ordinance or a local general plan should focus on the secondary effects that can be expected to follow from the adoption or amendment, but the EIR need not be as detailed as an EIR on the specific construction projects that might follow.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code. Formerly Section 15147.

Discussion: This section is necessary to deal with the wide range of activities which are subject to the CEQA process. Some activities such as the adoption of local general plans may deal with issues on a level of broad generalities. At the other end of the scale, CEQA also applies to conditional use permits for specific development projects. While CEQA requirements cannot be avoided by chopping the proposed project into pieces to render its impacts insignificant the EIR need not engage in a speculative analysis of environmental consequences for future and unspecified development. (Atherton v. Board of Supervisors of Orange County, (1983) 146 Cal. 3d 346.)

As with the range of alternatives, the level of analysis provided in an EIR is subject to the rule of reason. The level of specificity for a given EIR depends upon the type of project. The analysis must be specific enough to permit informed decision making and public participation. The need for thorough discussion and analysis is not to be construed unreasonably, however, to serve as an easy way of defeating projects. What is required is the production of information sufficient to understand the environmental impacts of the proposed project and to permit a reasonable choice of alternatives so far as environmental aspects are concerned. See Laurel Heights Improvement Association v. Regents of the University of California (1988) 47 Cal. 3d 376. In Antioch v. Pittsburg (1986) 187 Cal. App. 3d 1325, the court held that EIR requirements must be sufficiently flexible to encompass vastly differing projects with varying levels of specificity. When the alternatives have been set forth in this manner, an EIR does not become vulnerable because it fails to consider in detail each and every conceivable variation of the alternatives stated.

15147. Technical Detail

The information contained in an EIR shall include summarized technical data, maps, plot plans, diagrams, and similar relevant information sufficient to permit full assessment of significant environmental impacts by reviewing agencies and members of the public. Placement of highly technical and specialized analysis and data in the body of an EIR should be avoided through inclusion of supporting information and analyses as appendices to the main body of the EIR. Appendices to the EIR may be prepared in volumes separate from the basic EIR document, but shall be readily available for public examination and shall be submitted to all clearinghouses which assist in public review.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This section is designed to achieve a balance between the technical accuracy of the EIR and the public information function of the document. Accuracy can be maintained by moving the technical details into appendices and summarizing the technical information in the body of the EIR itself. This approach may help reduce the cost of the EIR. The Lead Agency may reproduce fewer copies of the appendices than of the basic EIR. This section follows the federal NEPA regulations which already encourage placement of technical details in appendices.

15148. Citation

Preparation of EIRs is dependent upon information from many sources, including engineering project reports and many scientific documents relating to environmental features. These documents should be cited but not included in the EIR. The EIR shall cite all documents used in its preparation including, where possible, the page and section number of any technical reports which were used as the basis for any statements in the EIR.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This section recognizes source documents but discourages their inclusion in the EIR. Citations are required for accountability and to allow statements to be verifiable. This section is necessary to keep the size of the EIRs down to manageable levels and at the same time maintain the accuracy of the information in the document.

15149. Use of Registered Professionals in Preparing EIRs

(a) A number of statutes provide that certain professional services can be provided to the public only by individuals who have been registered by a registration board established under California law. Such statutory restrictions apply to a number of professions including but not limited to engineering, land surveying, forestry, geology, and geophysics.

(b) In its intended usage, an EIR is not a technical document that can be prepared only by a registered professional. The EIR serves as a public disclosure document explaining the effects of the proposed project on the environment, alternatives to the project, and ways to minimize adverse effects and to increase beneficial effects. As a result of information in the EIR, the Lead Agency should establish requirements or conditions on project design, construction, or operation in order to protect or enhance the environment. State statutes may provide that only registered professionals can prepare technical studies which will be used in or which will control the detailed design, construction, or operation of the proposed project and which will be prepared in support of an EIR.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This section is necessary for declaring that an EIR is not the kind of technical document which can be prepared only by a person registered under a professional registration law in California. The section recognizes that some technical background documents may be legally prepared only by registered professionals.

15150. Incorporation by Reference

(a) An EIR or Negative Declaration may incorporate by reference all or portions of another document which is a matter of public record or is generally available to the public. Where all or part of another document is incorporated by reference, the incorporated language shall be considered to be set forth in full as part of the text of the EIR or Negative Declaration.

(b) Where part of another document is incorporated by reference, such other document shall be made available to the public for inspection at a public place or public building. The EIR or Negative Declaration shall state where the incorporated documents will be available for inspection. At a minimum, the incorporated document shall be made available to the public in an office of the Lead Agency in the county where the project would be carried out or in one or more public buildings such as county offices or public libraries if the Lead Agency does not have an office in the county.

(c) Where an EIR or Negative Declaration uses incorporation by reference, the incorporated part of the referenced document shall be briefly summarized where possible or briefly described if the data or information cannot be summarized. The relationship between the incorporated part of the referenced document and the EIR shall be described.

(d) Where an agency incorporates information from an EIR that has previously been reviewed through the state review system, the state identification number of the incorporated document should be included in the summary or designation described in subsection (c).

(e) Examples of materials that may be incorporated by reference include but are not limited to:

(1) A description of the environmental setting from another EIR.

(2) A description of the air pollution problems prepared by an air pollution control agency concerning a process involved in the project.

(3) A description of the city or county general plan that applies to the location of the project.

(4) Incorporation by reference is most appropriate for including long, descriptive, or technical materials that provide general background but do not contribute directly to the analysis of the problem at hand.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: Incorporation by reference is a necessary device for reducing the size of EIRs. This section authorizes use of incorporation by reference and provides guidance for using it in a manner consistent with the public involvement and full disclosure functions of CEQA.

15151. Standards for Adequacy of an EIR

An EIR should be prepared with a sufficient degree of analysis to provide decision-makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among experts does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among the experts. The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure.


Discussion: This section is a codification of case law dealing with the standards for adequacy of an EIR.

In Concerned Citizens of Costa Mesa, Inc. v. 32nd District Agricultural Assoc. (1986) 42 Cal. 3d 929, the court held that "the EIR must contain facts and analysis, not just the agency's bare conclusions or opinions." In Browning-Ferris Industries of California, Inc. v. San Jose (1986) 141 Cal. App. 3d 852, the court reasserted that an EIR is a disclosure document and as such an agency may choose among differing expert opinions when those arguments are correctly identified in a responsive manner. Further, the state Supreme Court in its 1988 Laurel Heights decision held that the purpose of CEQA is to compel government at all levels to make decisions with environmental consequences in mind. CEQA does not, indeed cannot, guarantee that these decisions will always be those which favor environmental considerations, nor does it require absolute perfection in an EIR.

15152. Tiering

(a) "Tiering" refers to using the analysis of general matters contained in a broader EIR (such as one prepared for a general plan or policy statement) with later EIRs and negative declarations on narrower projects; incorporating by reference the general discussions from the broader EIR; and concentrating the later EIR or negative declaration solely on the issues specific to the later project.

(b) Agencies are encouraged to tier the environmental analyses which they prepare for separate but
related projects including general plans, zoning changes, and development projects. This approach can eliminate repetitive discussions of the same issues and focus the later EIR or negative declaration on the actual issues ripe for decision at each level of environmental review. Tiering is appropriate when the sequence of analysis is from an EIR prepared for a general plan, policy, or program to an EIR or negative declaration for another plan, policy, or program of lesser scope, or to a site-specific EIR or negative declaration. Tiering does not excuse the lead agency from adequately analyzing reasonably foreseeable significant environmental effects of the project and does not justify deferring such analysis to a later tier EIR or negative declaration. However, the level of detail contained in a first tier EIR need not be greater than that of the program, plan, policy, or ordinance being analyzed.

(c) Where a lead agency is using the tiering process in connection with an EIR for a large-scale planning approval, such as a general plan or component thereof (e.g., an area plan or community plan), the development of detailed, site-specific information may not be feasible but can be deferred, in many instances, until such time as the lead agency prepares a future environmental document in connection with a project of a more limited geographical scale, as long as deferral does not prevent adequate identification of significant effects of the planning approval at hand.

(d) Where an EIR has been prepared and certified for a program, plan, policy, or ordinance consistent with the requirements of this section, any lead agency for a later project pursuant to or consistent with the program, plan, policy, or ordinance should limit the EIR or negative declaration on the later project to effects which:

(1) Were not examined as significant effects on the environment in the prior EIR, or

(2) Are susceptible to substantial reduction or avoidance by the choice of specific revisions in the project, by the imposition of conditions, or other means.

(e) Tiering under this section shall be limited to situations where the project is consistent with the general plan and zoning of the city or county in which the project is located, except that a project requiring a rezone to achieve or maintain conformity with a general plan may be subject to tiering.

(f) A later EIR shall be required when the initial study or other analysis finds that the later project may cause significant effects on the environment that were not adequately addressed in the prior EIR. A negative declaration shall be required when the provisions of Section 15070 are met.

(1) Where a lead agency determines that a cumulative effect has been adequately addressed in the prior EIR, that effect is not treated as significant for purposes of the later EIR or negative declaration, and need not be discussed in detail.

(2) When assessing whether there is a new significant cumulative effect, the lead agency shall consider whether the incremental effects of the project would be considerable when viewed in the context of past, present, and probable future projects. At this point, the question is not whether there is a significant cumulative impact, but whether the effects of the project are cumulatively considerable. For a discussion on how to assess whether project impacts are cumulatively considerable, see Section 15064(i).

(3) Significant environmental effects have been "adequately addressed" if the lead agency determines that:

(A) they have been mitigated or avoided as a result of the prior environmental impact report and findings adopted in connection with that prior environmental report;

(B) they have been examined at a sufficient level of detail in the prior environmental impact report to enable those effects to be mitigated or avoided by site specific revisions, the imposition of conditions, or by other means in connection with the approval of the later project; or

(C) they cannot be mitigated to avoid or substantially lessen the significant impacts despite the project proponent's willingness to accept all feasible mitigation measures, and the only purpose of including analysis of such effects in another environmental impact report would be to put the agency in a position to adopt a statement of overriding considerations with respect to the effects.
(g) When tiering is used, the later EIRs or negative declarations shall refer to the prior EIR and state where a copy of the prior EIR may be examined. The later EIR or negative declaration should state that the lead agency is using the tiering concept and that it is being tiered with the earlier EIR.

(h) There are various types of EIRs that may be used in a tiering situation. These include, but are not limited to, the following:

(1) General plan EIR (Section 15166).

(2) Staged EIR (Section 15167).

(3) Program EIR (Section 15168).

(4) Master EIR (Section 15175).

(5) Multiple-family residential development / residential and commercial or retail mixed-use development (Section 15179.5).

(6) Redevelopment project (Section 15180).

(7) Housing / neighborhood commercial facilities in an urbanized area (Section 15181).

(8) Projects consistent with community plan, general plan, or zoning (Section 15183).


Discussion: The tiering concept authorized in this section is designed to promote efficiency in the process and to improve the compatibility of the CEQA process with the NEPA process. This section recognizes that the approval of many projects will move through a series of separate public agency decisions, going from approval of a general plan, to approval of an intermediate plan or zoning, and finally to approval of a specific development proposal. Each of these approvals is subject to the CEQA process. Often, the EIR prepared for a particular approval re-examines all the environmental issues analyzed in the EIRs prepared for the earlier approvals. This approach involves unnecessary expense when a particular issue has been fully analyzed before. Tiering is an effort to focus environmental review on the environmental issues which are relevant to the approval being considered. At the same time, tiering requires the lead agency to analyze reasonably foreseeable significant effects and does not allow deferral of such analysis to a later tier document.

This section expands the guidance on use of tiering. This section follows the general approach taken in Public Resources Code Section 21083.3. That section authorizes tiering of EIRs for projects which were consistent with an adopted community plan for which an EIR was prepared. This section extends the tiering concept to all programs, plans, or policies for which an EIR was prepared. This section improves efficiency by encouraging the Lead Agency to limit the EIR or the Negative Declaration on a later project, which is pursuant to or consistent with the program, plan, or policy, to examining the significant effects which were not examined as significant effects in the prior EIR or are susceptible to substantial reduction or avoidance by specific revisions in the project. The section allows use of tiering even where the action on the prior project and EIR did not include mitigation for every significant effect.

This approach recognizes that not all effects can be mitigated at each step of the process. There will be some effects for which mitigation will not be feasible at an early step of approving a particular development project, and the section would allow a Lead Agency to defer mitigation of that kind of effect to a later step. Such effects may include site specific effects such as aesthetics or parking, depending on the circumstances. At the same time, this section makes clear that tiering does not excuse the Lead Agency from analyzing reasonably foreseeable significant effects, or justify deferring analysis to a later tier EIR or Negative Declaration.

Where tiering is used, the Lead Agency will need to determine whether, in the light of changing circumstances, the EIR prepared earlier in the process would still provide an adequate description of the broad effects considered at that stage. Tiering enables an agency to rely upon the analysis contained in a previous document when it adequately addresses a later project. Subdivision (e) describes what is meant by inadequately addressed in such a way as to ensure that prior mitigation measures will be applied to the later project.

To make the process understandable, any EIR or Negative Declaration using the tiering principle must refer to the prior EIR, state where a copy of that document may be examined, and state that tiering is being used.

15153. Use of an EIR from an Earlier Project

(a) The Lead Agency may employ a single EIR to describe more than one project, if such projects are essentially the same in terms of environmental impact. Further, the Lead Agency may use an earlier EIR prepared in connection with an earlier project to apply to a later project, if the circumstances of the projects are essentially the same.

(b) When a Lead Agency proposes to use an EIR from an earlier project as the EIR for a separate, later project, the Lead Agency shall use the following procedures:

(1) The Lead Agency shall review the proposed project with an Initial Study, using incorporation by reference if necessary, to determine whether the EIR would adequately describe:

(A) The general environmental setting of the project,

(B) The significant environmental impacts of the project, and

(C) Alternatives and mitigation measures related to each significant effect.

(2) If the Lead Agency believes that the EIR would meet the requirements of subsection (1), it shall provide public review as provided in Section 15087 stating that it plans to use the previously prepared EIR as the draft EIR for this project. The notice shall include as a minimum:

(A) An identification of the project with a brief description;

(B) A statement that the agency plans to use a certain EIR prepared for a previous project as the EIR for this project;

(C) A listing of places where copies of the EIR may be examined; and

(D) A statement that the key issues involving the EIR are whether the EIR should be used for this project and whether there are any additional, reasonable alternatives or mitigation measures that should be considered as ways of avoiding or reducing the significant effects of the project.

(3) The Lead Agency shall prepare responses to comments received during the review period.

(4) Before approving the project, the decision-maker in the Lead Agency shall:

(A) Consider the information in the EIR including comments received during the review period and responses to those comments,

(B) Decide either on its own or on a staff recommendation whether the EIR is adequate for the project at hand, and

(C) Make or require certification to be made as described in Section 15090.

(D) Make findings as provided in Sections 15091 and 15093 as necessary.

(5) After making a decision on the project, the Lead Agency shall file a Notice of Determination.


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(c) An EIR prepared for an earlier project may also be used as part of an Initial Study to document a finding that a later project will not have a significant effect. In this situation a Negative Declaration will be prepared.

(d) An EIR prepared for an earlier project shall not be used as the EIR for a later project if any of the conditions described in Section 15162 would require preparation of a subsequent or supplemental EIR.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21100, 21151, and 21165, Public Resources Code.

Discussion: The purpose of this section is to grant Lead Agencies clear authority to use an EIR prepared for one project over again for a second project which has essentially the same impacts as the project for which the EIR was originally prepared. The section places necessary conditions on the use of a prior EIR to avoid abuse of this approach. Where two projects are essentially the same in terms of environmental impact, there is little reason to require preparation of a separate EIR for the second project.

Subsection (b) prescribes the procedures for an agency to use in implementing this authority. Use of a Negative Declaration is not appropriate. Although a Negative Declaration does state that an EIR will not be prepared, the reason for preparing a Negative Declaration is that the project will not have a significant effect. An EIR is needed if the project may have a significant effect although under some circumstances a previously prepared EIR may be used as the basis for review. The procedures prescribed in subsection (b) should reduce the confusion that has often been experienced in this situation.

This section is different from tiering in that this process does not involve a series of approvals moving from the general to the specific with EIRs omitting issues fully addressed at the earlier stages. The use of a previously prepared EIR is most appropriate where an EIR was prepared earlier for a project very similar to the one currently being examined by the Lead Agency.

15154. Projects Near Airports

(a) When a lead agency prepares an EIR for a project within the boundaries of a comprehensive airport land use plan or, if a comprehensive airport land use plan has not been adopted for a project within two nautical miles of a public airport or public use airport, the agency shall utilize the Airport Land Use Planning Handbook published by Caltrans' Division of Aeronautics to assist in the preparation of the EIR relative to potential airport-related safety hazards and noise problems.

(b) A lead agency shall not adopt a negative declaration or mitigated negative declaration for a project described in subsection (a) unless the lead agency considers whether the project will result in a safety hazard or noise problem for persons using the airport or for persons residing or working in the project area.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21096, Public Resources Code.
Title 14. California Code of Regulations
Chapter 3. Guidelines for Implementation of the California Environmental Quality Act

Article 18. Statutory Exemptions

Sections 15260 to 15285

(Note: Newly revised language is underlined; deleted language is stricken through. The numbered sections have been adopted by the Secretary of Resources as part of the California Code of Regulations. The discussions after each section are provided by the Governor's Office of Planning and Research; they are not in the California Code of Regulations.)

15260. General

This article describes the exemptions from CEQA granted by the Legislature. The exemptions take several forms. Some exemptions are complete exemptions from CEQA. Other exemptions apply to only part of the requirements of CEQA, and still other exemptions apply only to the timing of CEQA compliance.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b), Public Resources Code.

Discussion: This section serves as an introduction to this article on statutory exemptions. The section notes that the exemptions take basically three forms, being either complete exemptions, partial exemptions, or special timing requirements.

The court in Western Municipal Water District of Riverside County v. Superior Court of San Bernardino County (1986) 187 Cal. App. 3d 1104, pointed out that "the self-evident purpose of a [statutory] exemption is to provide an escape from the EIR requirement despite a project's clear, significant impact." This is in contrast to categorical exemptions which are disallowed if the project would otherwise have an environmental impact.

By way of example, the Supreme Court held in Napa Valley Wine Train, Inc. v. Public Utilities Commission (1990) 50 Cal.3d 370, that CEQA is a legislative act subject to legislative limitations and legislative amendment. Through that premise, the court held that statutory exemptions were enacted to avoid the environmental review process for an entire class of projects. In the specific case, an excursion train proposed for operation within an existing railroad right-of-way fell within the exemption language in Public Resources Code Section 21080(b)(11), even though the use might have potential environmental consequences. Subsequent legislation enacted Public Resources Code Section 21080.04 making the wine train project subject to CEQA.

15261. Ongoing Project
(a) If a project being carried out by a public agency was approved prior to November 23, 1970, the project shall be exempt from CEQA unless either of the following conditions exist:

(1) A substantial portion of public funds allocated for the project have not been spent, and it is still feasible to modify the project to mitigate potentially adverse environmental effects, or to choose feasible alternatives to the project, including the alternative of "no project" or halting the project; provided that a project subject to the National Environmental Policy Act (NEPA) shall be exempt from CEQA as an ongoing project if, under regulations promulgated under NEPA, the project would be too far advanced as of January 1, 1970, to require preparation of an EIS.

(2) A public agency proposes to modify the project in such a way that the project might have a new significant effect on the environment.

(b) A private project shall be exempt from CEQA if the project received approval of a lease, license, certificate, permit, or other entitlement for use from a public agency prior to April 5, 1973, subject to the following provisions:

(1) CEQA does not prohibit a public agency from considering environmental factors in connection with the approval or disapproval of a project, or from imposing reasonable fees on the appropriate private person or entity for preparing an environmental report under authority other than CEQA. Local agencies may require environmental reports for projects covered by this paragraph pursuant to local ordinances during this interim period.

(2) Where a project was approved prior to December 5, 1972, and prior to that date the project was legally challenged for noncompliance with CEQA, the project shall be bound by special rules set forth in Section 21170 of CEQA.

(3) Where a private project has been granted a discretionary governmental approval for part of the project before April 5, 1973, and another or additional discretionary governmental approvals after April 5, 1973, the project shall be subject to CEQA only if the approval or approvals after April 5, 1973, involve a greater degree of responsibility or control over the project as a whole than did the approval or approvals prior to that date.


Discussion: While not specifically mentioned among the statutory exemptions contained in CEQA, the ongoing project exemption is a result of the prospective application of statutes when they are enacted. Accordingly, CEQA clearly applies to governmental projects approved after November 23, 1970, the effective date of CEQA. This section seeks to codify case law interpreting the application of CEQA to projects which were in process at the time of CEQA's effective date but not yet finally approved or still capable of being changed to avoid environmental damage. This section is also complicated by the special rules that apply to private projects approved after the Friends of Mammoth decision in 1972 and before April 5, 1973, the end of the statutory moratorium on the application of CEQA to private projects. The special rules are included here with some administrative interpretation in the interest of completeness of the ongoing project exception.

15262. Feasibility and Planning Studies

A project involving only feasibility or planning studies for possible future actions which the agency, board, or commission has not approved, adopted, or funded does not require the preparation of an EIR or Negative Declaration but does require consideration of environmental factors. This section does not apply to the adoption of a plan that will have a legally binding effect on later activities.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21102 and 21150, Public Resources Code.

Discussion: This section provides an interpretation of the exception in CEQA for feasibility and planning studies. This section provides an interpretation holding clearly that feasibility and planning...
studies are exempt from the requirements to prepare EIRs or Negative Declarations. These studies must still include consideration of environmental factors. This interpretation is consistent with the intent of the Legislature as reflected in Sections 21102 and 21150. The section also adds a necessary limitation on this exemption to show that if the adoption of a plan will have a legally binding effect on later activities, the adoption will be subject to CEQA. This clarification is necessary to avoid a conflict with Section 15378(a)(1) that the adoption of a local general plan is a project subject to CEQA.

15263. Discharge Requirements

The State Water Resources Control Board and the regional boards are exempt from the requirement to prepare an EIR or a Negative Declaration prior to the adoption of waste discharge requirements, except requirements for new sources as defined in the Federal Water Pollution Control Act or in other acts which amend or supplement the Federal Water Pollution Control Act. The term "waste discharge requirements" as used in this section is the equivalent of the term "permits" as used in the Federal Water Pollution Control Act.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 13389, Water Code.

Discussion: This section identifies and interprets the exemption for waste discharge requirements from existing sources under the Federal Water Pollution Control Act. This exemption is contained in the Water Code and would not be readily discovered by anybody reviewing CEQA. This Guideline section specifies that this partial exemption applies only to the preparation of EIRs and Negative Declarations. This is not a total exemption in CEQA. This section is included in the interest of completeness of this article and as part of the effort to bring together in one place the many different exemptions which are scattered throughout the codes.

15264. Timberland Preserves

Local agencies are exempt from the requirement to prepare an EIR or Negative Declaration on the adoption of timberland preserve zones under Government Code Sections 51100 et seq. (Gov. Code, Sec. 51119).


Discussion: This exemption is also a partial exemption applying only to the requirement to prepare an EIR or Negative Declaration. This section repeats the exemption found in Section 51119 of the Government Code. The exemption noted there would be difficult for people to find when they are reviewing the CEQA statute and trying to determine its application to the activity.

15265. Adoption of Coastal Plans and Programs

(a) CEQA does not apply to activities and approvals pursuant to the California Coastal Act (commencing with Section 30000 of the Public Resources Code) by:

(1) Any local government, as defined in Section 30109 of the Public Resources Code, necessary for the preparation and adoption of a local coastal program, or

(2) Any state university or college, as defined in Section 30119, as necessary for the preparation and adoption of a long-range land use development plan.

(b) CEQA shall apply to the certification of a local coastal program or long-range land use development plan by the California Coastal Commission.

(c) This section shifts the burden of CEQA compliance from the local agency or the state university or college to the California Coastal Commission. The Coastal Commission's program of certifying local

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coastal programs and long-range land use development plans has been certified under Section 21080.5, Public Resources Code. See: Section 15192.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.9, Public Resources Code.

Discussion: This section identifies and explains the exemption which applies to the certification of coastal plans and programs. The section shows that the exemption amounts to a shift in responsibility from local governments and the state university and college system to the California Coastal Commission. The section also notes that the process used by the Coastal Commission in approving the local coastal programs or the long-range land use development plans by the state university or colleges has been certified as a "functional equivalent" program so that the Coastal Commission can use a short form of CEQA compliance. This section is necessary to explain how CEQA applies to local coastal programs and long-range land use development plans.

15266. General Plan Time Extension

CEQA shall not apply to the granting of an extension of time by the Office of Planning and Research to a city or county for the preparation and adoption of one or more elements of a city or county general plan.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.10(a), Public Resources Code.

Discussion: This section is necessary to make it clear that CEQA does not apply to all the actions of the Office of Planning and Research in granting an extension of time to a city or county for the preparation and adoption of one or more elements of a local general plan.

15267. Financial Assistance to Low or Moderate Income Housing

CEQA does not apply to actions taken by the Department of and Community Development to provide financial assistance for the development and construction of residual housing for persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code. The residential project which is the subject of the application for financial assistance will be subject to CEQA where approvals are granted by another agency.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.10(b), Public Resources Code.

Discussion: This section identifies and interprets the exemption granted to the financial assistance activities of the state Department of Housing and Community Development which involve the development and construction of residual housing for persons of low or moderate income. The section notes that this exemption is not an exemption for the project which receives the funds. CEQA will apply to the approvals of the housing project by other agencies.

15268. Ministerial Projects

(a) Ministerial projects are exempt from the requirements of CEQA. The determination of what is "ministerial" can most appropriately be made by the particular public agency involved based upon its analysis of its own laws, and each public agency should make such determination either as a part of its implementing regulations or on a case-by-case basis.

(b) In the absence of any discretionary provision contained in the local ordinance or other law establishing the requirements for the permit, license, or other entitlement for use, the following actions shall be presumed to be ministerial:

(1) Issuance of building permits.
(2) Issuance of business licenses.

(3) Approval of final subdivision maps.

(4) Approval of individual utility service connections and disconnections.

(c) Each public agency should, in its implementing regulations or ordinances, provide an identification or itemization of its projects and actions which are deemed ministerial under the applicable laws and ordinances.

(d) Where a project involves an approval that contains elements of both a ministerial action and a discretionary action, the project will be deemed to be discretionary and will be subject to the requirements of CEQA.


Discussion: This section provides an interpretation of the exemption for ministerial projects. The term "ministerial" is defined in Section 15369. This section provides additional explanation. The key point is that the determination of whether a particular project is ministerial must be based on an examination of the law or ordinance authorizing the particular permit. The problem is that ordinances vary. Ordinances in adjacent counties requiring permits for the same kind of activity may provide different kinds of controls over the activity. In one county, the ordinance may be ministerial, and in the other the permit may be discretionary and therefore subject to CEQA. The section identifies four types of permits or licenses which are normally ministerial in most jurisdictions. The section creates a presumption that these activities are ministerial unless evidence is presented showing that there are discretionary provisions in the relevant local ordinance.

The section encourages public agencies to identify their ministerial permits in their implementing procedures. This approach will simplify the administration of the process in the individual agency. This section also codifies the ruling in Day v. City of Glendale cited in the note and other court decisions which have held that where a project approval involves elements of both ministerial action and discretionary action, the project will be deemed to be discretionary and therefore subject to CEQA.

The court in Friends of Westwood, Inc. v. Los Angeles (1986) 191 Cal. App. 3d 259, provided guidance, and held that the legislative history of CEQA indicates that the term 'Ministerial' is limited to those approvals which can be legally compelled without substantial modification or change. "It is enough that the [agency] possesses discretion to require changes which would mitigate in whole or part one or more of the [significant or potentially significant] environmental consequences an EIR might conceivably uncover."

15269. Emergency Projects

The following emergency projects are exempt from the requirements of CEQA.

(a) Projects to maintain, repair, restore, demolish, or replace property or facilities damaged or destroyed as a result of a disaster in a disaster stricken area in which a state of emergency has been proclaimed by the Governor pursuant to the California Emergency Services Act, commencing with Section 8550 of the Government Code. This includes projects that will remove, destroy, or significantly alter an historical resource when that resource represents an imminent threat to the public of bodily harm or of damage to adjacent property or when the project has received a determination by the State Office of Historic Preservation pursuant to Section 5028(b) of Public Resources Code.

(b) Emergency repairs to publicly or privately owned service facilities necessary to maintain service essential to the public health, safety or welfare.

(c) Specific actions necessary to prevent or mitigate an emergency. This does not include long-term projects undertaken for the purpose of preventing or mitigating a situation that has a low probability of
occurrence in the short-term.

(d) Projects undertaken, carried out, or approved by a public agency to maintain, repair, or restore an existing highway damaged by fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide, provided that the project is within the existing right of way of that highway and is initiated within one year of the damage occurring. This exemption does not apply to highways designated as official state scenic highways, nor any project undertaken, carried out, or approved by a public agency to expand or widen a highway damaged by fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide.

(e) Seismic work on highways and bridges pursuant to Section 180.2 of the Streets and Highways Code, Section 180 et seq.


Discussion: This section identifies the emergency exemptions from CEQA. The exemptions for emergency repairs to existing highways and for emergency projects involving historical resources that are an imminent threat to the public reflect statutory provisions. Highway repairs are limited to those which do not expand or widen the highway.

In Western Municipal Water District of Riverside County v. Superior Court of San Bernardino County (1987) 187 Cal. App. 3d 1104, the court held that an emergency is an occurrence, not a condition, and that the occurrence must involve a clear and imminent danger, demanding immediate attention. In this case, the water district proposed to dewater areas that could potentially be subject to liquefaction in the event of an earthquake. The excess water was to be pumped out to reduce the hazard as an emergency project. The court, however, ruled that this was not the proper use of this exemption. The imminence of an earthquake is not a condition but a potential event and no real change had yet occurred or could be incontestably foreseen as being mitigated by the proposed actions. The standard of review is there must be substantial evidence in the record to support the agency findings of an emergency, in this case, the Court found inadequate evidence of imminent danger and the subsequent need for immediate action. This holding is now codified in subsection (e).

15270. Projects Which are Disapproved

(a) CEQA does not apply to projects which a public agency rejects or disapproves.

(b) This section is intended to allow an initial screening of projects on the merits for quick disapprovals prior to the initiation of the CEQA process where the agency can determine that the project cannot be approved.

(c) This section shall not relieve an applicant from paying the costs for an EIR or Negative Declaration prepared for his project prior to the Lead Agency’s disapproval of the project after normal evaluation and processing.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(5), Public Resources Code.

Discussion: This section identifies and interprets the exemption for disapprovals. This exemption was originally added to CEQA to clarify that a public agency could turn down a permit application without first preparing an EIR or Negative Declaration. Subsection (c) makes the point that if the public agency prepares an EIR or Negative Declaration for the project, and then the agency decides to disapprove the project, the project applicant must still pay the cost of that EIR or Negative Declaration.

This section may also be used to avoid automatic approvals. If an applicant was not cooperative in providing requested information in a timely manner, and as a result the agency could not complete the CEQA process in the required time, the agency can disapprove the project to prevent the permit from
being granted by operation of law without the mitigation measures that would have been developed through the CEQA process.

15271. Early Activities Related to Thermal Power Plants

(a) CEQA does not apply to actions undertaken by a public agency relating to any thermal power plant site or facility including the expenditure, obligation, or encumbrance of funds by a public agency for planning, engineering, or design purposes, or for the conditional sale or purchase of equipment, fuel, water (except groundwater), steam, or power for such a thermal power plant, if the thermal power plant site and related facility will be the subject of an EIR or Negative Declaration or other document or documents prepared pursuant to a regulatory program certified pursuant to Public Resources Code Section 21080.5, which will be prepared by:

(1) The State Energy Resources Conservation and Development Commission,

(2) The Public Utilities Commission, or

(3) The city or county in which the power plant and related facility would be located.

(b) The EIR, Negative Declaration, or other document prepared for the thermal power plant site or facility, shall include the environmental impact, if any, of the early activities described in this section.

(c) This section acts to delay the timing of CEQA compliance from the early activities of a utility to the time when a regulatory agency is requested to approve the thermal power plant and shifts the responsibility for preparing the document to the regulatory agency.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 15080 (b)(6), Public Resources Code.

Discussion: This section identifies and interprets the exemption for early activities related to thermal electric power plants. This section delays the CEQA compliance for thermal power plants for all utilities until the power plant needed approval from a regulatory agency. The statutory exception provides that when an EIR, Negative Declaration, or a document under a certified program is prepared, that document must include the environmental impacts of any of the early activities described in the section as being exempt from CEQA compliance.

Subsection (c) explains the purpose as shifting both the timing and the responsibility for preparing the EIR. Although the utility would ultimately pay for the cost, preparing the document would be the responsibility of the regulatory agency.

15272. Olympic Games

CEQA does not apply to activities or approvals necessary to the bidding for, hosting or staging of, and funding or carrying out of, Olympic Games under the authority of the International Olympic Committee, except for the construction of facilities necessary for such Olympic Games. If the facilities are required by the International Olympic Committee as a condition of being awarded the Olympic Games, the Lead Agency need not discuss the "no project" alternative in an EIR with respect to those facilities.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(7), Public Resources Code.

15273. Rates, Tolls, Fares, and Charges

(a) CEQA does not apply to the establishment, modification, structuring, restructuring, or approval of rates, tolls, fares, or other charges by public agencies which the public agency finds are for the purpose of:
(1) Meeting operating expenses, including employee wage rates and fringe benefits,
(2) Purchasing or leasing supplies, equipment, or materials,
(3) Meeting financial reserve needs and requirements,
(4) Obtaining funds for capital projects, necessary to maintain service within existing service areas, or
(5) Obtaining funds necessary to maintain such intra-city transfers as are authorized by city charter.

(b) Rate increases to fund capital projects for the expansion of a system remain subject to CEQA. The agency granting the rate increase shall act either as the Lead Agency if no other agency has prepared environmental documents for the capital project or as a Responsible Agency if another agency has already complied with CEQA as the Lead Agency.

(c) The public agency shall incorporate written findings in the record of any proceeding in which an exemption under this section is claimed setting forth with specificity the basis for the claim of exemption.

Notes: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(8), Public Resources Code.

Discussion: This section identifies and interprets the exemption that applies to the adoption of rates, tolls, fares, and other charges. The section spells out the provisions of the statutory exemption for these charges and in summary form provides an interpretation of the kinds of rate increases that still remain subject to CEQA. The section also identifies the requirement to make written findings to support the claim that the rate change falls within the specific exemptions provided in this section. These findings are an unusual requirement with an exemption and need to be highlighted.

15274. Family Day Care Homes

(a) CEQA does not apply to establishment or operation of a large family day care home, which provides in-home care for up to fourteen children, as defined in Section 1596.78 of the Health and Safety Code.

(b) Under the Health and Safety Code, local agencies cannot require use permits for the establishment or operation of a small family day care home, which provides in-home care for up to eight children, and the establishment or operation of a small family day care home is a ministerial action which is not subject to CEQA.

Notes: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21083, Public Resources Code.

15275. Specified Mass Transit Projects

CEQA does not apply to the following mass transit projects:

(a) The institution or increase of passenger or commuter service on rail lines or high-occupancy vehicle lanes already in use, including the modernization of existing stations and parking facilities;

(b) Facility extensions not to exceed four miles in length which are required for transfer of passengers from or to exclusive public mass transit guideway or busway public transit services.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(11), (12), and (13), Public Resources Code.

Discussion: This section combined several exemptions that apply to mass transit projects. The revised
description of these projects clarifies the nature of the exemption and the activities to which the exemption applies.

15276. Transportation Improvement and Congestion Management Programs

(a) CEQA does not apply to the development or adoption of a regional transportation improvement program or the state transportation improvement program. Individual projects developed pursuant to these programs shall remain subject to CEQA.

(b) CEQA does not apply to preparation and adoption of a congestion management program by a county congestion management agency pursuant to Government Code Section 65089, et seq.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(13), Public Resources Code.

Discussion: This section identifies and interprets the exemptions that apply to the development or adoption of state and regional transportation improvement programs, as well as congestion management plans. The section clarifies that the exemption for transportation improvement programs does not apply to individual projects undertaken pursuant to such programs.

The California Supreme Court held, in Napa Valley Wine Train, Inc. v. Public Utilities Commission (1990) 50 Cal.3d 370, that rail passenger service is to be construed with reference to the existence of a rail right of way and not the physical rail line, its condition, or type of rail traffic. In this case, the fact that the existing rail right of way had not been formally abandoned, not its physical existence or frequency of recent pattern of use of the line was the pertinent criteria. See also the discussion for Section 15260.

15277. Projects Located Outside California

CEQA does not apply to any project or portion thereof located outside of California which will be subject to environmental impact review pursuant to the National Environmental Policy Act of 1969 or pursuant to a law of that state requiring preparation of a document containing essentially the same points of analysis as an Environmental Impact Statement prepared under the National Environmental Policy Act of 1969. Any emissions or discharges that would have a significant effect on the environment in the State of California are subject to CEQA where a California public agency has authority over the emissions or discharges.


Discussion: The section identifies and interprets the exemption that applies to projects located in another state. The section repeats part of the statutory language and provides further explanation.

This partial exemption from CEQA was a response to an Attorney General's opinion stating that when a California public agency takes an action outside of the State of California, the California agency is still bound by the requirements in CEQA to prepare an EIR if the agency's action would cause a significant effect on the environment. The Attorney General's opinion noted that the definition of the term "environment" in CEQA did not stop at the borders of the State of California. It said that CEQA applies to any exercise of powers by a California state or local agency. Where the agency was exercising powers granted by the Legislature, they were also subject to constraints enacted by the Legislature. Accordingly, when the California Department of Water Resources proposed to build a power plant in Nevada, the Department prepared an EIR analyzing the effects of its proposed action on the environment. This section will apply mostly where California public agencies undertake their own projects outside the state.

15278. Application of Coatings

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(a) CEQA does not apply to a discretionary decision by an air quality management district for a project consisting of the application of coatings within an existing facility at an automotive manufacturing plant if the district finds all of the following:

(1) The project will not cause a net increase in any emissions of any pollutant for which a national or state ambient air quality standard has been established after the internal emission accounting for previous emission reductions achieved at the facility and recognized by the district.

(2) The project will not cause a net increase in adverse impacts of toxic air contaminants as determined by a health risk assessment. The term "net increase in adverse impacts of toxic air contaminants as determined by a health risk assessment" shall be determined in accordance with the rules and regulations of the district.

(3) The project will not cause any other adverse effect on the environment.

(b) The district shall provide a 10-day notice, at the time of the issuance of the permit, of any such exemption. Notice shall be published in two newspapers of general circulation in the area of the project and shall be mailed to any person who makes a written request for such a notice. The notice shall state that the complete file on the project and the basis for the district's findings of exemption are available for inspection and copying at the office of the district.

(c) Any person may appeal the issuance of a permit based on an exemption under subdivision (a) to the hearing board as provided in Section 42302.1 of the Health and Safety Code. The permit shall be revoked by the hearing board if there is substantial evidence in light of the whole record before the board that the project may not satisfy one or more of the criteria established pursuant to subdivision (a). If there is no such substantial evidence, the exemption shall be upheld. Any appeal under this subdivision shall be scheduled for hearing on the calendar of the hearing board within 10 working days of the appeal being filed. The hearing board shall give the appeal priority on its calendar and shall render a decision on the appeal within 21 working days of the appeal being filed. The hearing board may delegate the authority to hear and decide such an appeal to a subcommittee of its body.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Chapter 1131, Statutes of 1993, Section 1.

15279. Housing for Agricultural Employees

(a) CEQA does not apply to any development project which consists of the construction, conversion, or use of residential housing for agricultural employees, as defined below, provided the development is either:

(1) Affordable to lower income households, as defined in Section 50079.5 of the Health and Safety Code, there is no public financial assistance for the development project, and the developer provides sufficient legal commitments to the appropriate local agency to ensure that the housing units will continue to be available to lower-income households for a period of at least 15 years; or

(2) Affordable to low and moderate-income households, as defined in paragraph (2) of subdivision (b) of Section 56589.5 of the Government Code, at monthly housing costs determined pursuant to paragraph (2) of subdivision (b) of Section 56589.5 of the Government Code, there is public financial assistance for the project, and the developer provides sufficient legal commitments to the appropriate local agency to ensure that the housing units will continue to be available to low and moderate-income households for a period of at least 15 years.

(b) The development must also meet all the following criteria:

(1) It is consistent with the applicable city, county, or city and county general plan as it existed on the date the project application was deemed complete.

(2) It is consistent with the local zoning, as it existed on the date the project application was deemed complete, unless the zoning is inconsistent with the general plan because the city, county, or city and
county has not rezoned the property to bring it into consistency with the general plan.

(3) If the project is proposed in an urbanized area, it does not exceed 45 dwelling units, or if it consists of dormitories, barracks or other group living facilities houses not more than 45 agricultural employees, and its site is adjacent on at least two sides to land that has been previously developed.

(4) If the project is proposed in a nonurbanized area, its site is zoned for general agricultural use and the project consists of not more than 20 dwelling units or, if it consists of dormitories, barracks or other group living facilities, it houses not more than 20 agricultural employees.

(5) Its site is not more than five acres in area, except that a project located in an area with a population density of at least 1000 persons per square mile shall not be more than two acres in area.

(6) Its site is, or can be, adequately served by utilities.

(7) Its site has no value as wildlife habitat.

(8) Its site is not included on any list of hazardous waste or other facilities and sites compiled pursuant to Section 65962 of the Government Code.

(9) It will not involve the demolition of, or any substantial adverse change in, any structure that is listed, or determined to be eligible for listing in the California Register of Historical Resources.

(c) As used in this section, "residential housing for agricultural employees" means housing accommodations for an agricultural employee, as defined in subdivision (b) of Section 1140.4 of the Labor Code.

(d) As used in this section, "urbanized area" means either of the following:

(1) an area with a population density of at least 1000 persons per square mile, or

(2) an area with a population density of less than 1000 persons per square mile that is identified as an urban area in the general plan adopted by the applicable city, county, or city and county and was not designated at the time the application was deemed complete as an area reserved for future urban growth.

(e) This section does not apply if the public agency which is carrying out or approving the development project determines that there is a reasonable possibility that the project would have a significant effect on the environment due to unusual circumstances or that the cumulative impact of successive projects of the same type in the same area over time would be significant.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.10, Public Resources Code.

Discussion: Public Resources Code section 21080.10 establishes a statutory exemption for agricultural employees housing. The conditions and limitations of this exemption are detailed in this section.

15280. Lower-income Housing Projects

(a) CEQA does not apply to any development project which consists of the construction, conversion, or use of residential housing consisting of not more than 100 45-units in an urbanized area, provided that it is either:

(1) Affordable to lower-income households, as defined in Section 50079.5 of the Health and Safety Code, and the developer provides sufficient legal commitments to the appropriate local agency to ensure that the housing units will continue to be available to lower income households for a period of at least 15 years; or

(2) Affordable to low and moderate-income households, as defined in paragraph (2) of subdivision (h)
of Section 65589.5 of the Government Code, at monthly housing costs determined pursuant to paragraph (2) of subdivision (h) of Section 65589.5 of the Government Code.

(b) The development must also meet all the following criteria:

(1) It is consistent with the local jurisdiction's general plan as it existed on the date the project application was deemed complete.

(2) It is consistent with the local zoning as it existed on the date the project application was deemed complete, unless the zoning is inconsistent with the general plan because the city, county, or city and county has not rezoned the property to bring it into consistency with the general plan.

(3) Its site has been previously developed or is currently developed with urban uses, or the immediately contiguous properties surrounding the site are or have been previously developed with urban uses.

(4) Its site is not more than two acres in area.

(5) Its site is, or can be, adequately served by utilities.

(6) Its site has no value as wildlife habitat.

(7) It will not involve the demolition of, or any substantial adverse change in, any district, landmark, object, building, structure, site, area, or place that is listed, or determined to be eligible for listing in the California Register of Historical Resources.

(8) Its site is not included on any list of hazardous waste or other facilities and sites compiled pursuant to Section 65962.5 of the Government Code, and the site has been subject to an assessment by a California registered environmental assessor to determine both the presence of hazardous contaminants, if any, and the potential for exposure of site occupants to significant health hazards from nearby properties and activities.

(c) For purposes of this section, "urbanized area" means an area that has a population density of at least 1000 persons per square mile.

(d) If hazardous contaminants are found on the site, they must be removed or any significant effects mitigated to a level of insignificance in order to apply this exemption. If a potential for exposure to significant health hazards from nearby properties and activities is found to exist, the effects of the potential exposure must be mitigated to a level of insignificance in order to apply this exemption. Any removal or mitigation to insignificance must be completed prior to any residential occupancy of the project.

(e) This section does not apply if there is a reasonable possibility that the project would have a significant effect on the environment due to unusual circumstances or due to the related or cumulative impacts of reasonably foreseeable other projects in the vicinity.


Discussion: Public Resources Code section 21080.14 establishes a statutory exemption for lower-income residential projects in urban areas. The conditions and limitations of this exemption are detailed in this section.

15281. Air Quality Permits

CEQA does not apply to the issuance, modification, amendment, or renewal of any permit by an air pollution control district or air quality management district pursuant to Title V, as defined in Section 39053.3 of the Health and Safety Code, or pursuant to an air district Title V program established under Sections 42301.10, 42301.11, and 42301.12 of the Health and Safety Code, unless the issuance, modification, amendment, or renewal authorizes a physical or operational change to a source or
facilty.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.24, Public Resources Code.

15282. Other Statutory Exemptions

The following is a list of existing statutory exemptions. Each subsection summarizes statutory exemptions found in the California Code. Lead agencies are not to rely on the language contained in the summaries below but must rely on the actual statutory language that creates the exemption. This list is intended to assist lead agencies in finding them, but not as a substitute for them. This section is merely a reference tool.

(a) The notification of discovery of Native American burial sites as set forth in Section 5097.98(c) of the Public Resources Code.

(b) Specified prison facilities as set forth in Sections 21080.01, 21080.02, 21080.03 and 21080.07 of the Public Resources Code.

(c) The lease or purchase of the rail right-of-way used for the San Francisco Peninsula commute service between San Francisco and San Jose as set forth in Section 21080.05 of the Public Resources Code.

(d) Any activity or approval necessary for or incidental to project finding or authorization for the expenditure of funds for the project, by the Rural Economic Development Infrastructure Panel as set forth in Section 21080.08 of the Public Resources Code.

(e) The construction of housing or neighborhood commercial facilities in an urbanized area pursuant to the provisions of Section 21080.7 of the Public Resources Code.

(f) The conversion of an existing rental mobilehome park to a resident initiated subdivision, cooperative, or condominium for mobilehomes as set forth in Section 21080.8 of the Public Resources Code.

(g) Settlements of title and boundary problems by the State Lands Commission and to exchanges or leases in connection with those settlements as set forth in Section 21080.11 of the Public Resources Code.

(h) Any railroad grade separation project which eliminates an existing grade crossing or which reconstructs an existing grade separation as set forth in Section 21080.13 of the Public Resources Code.

(i) The adoption of an ordinance regarding second units in a single-family or multifamily residential zone by a city or county to implement the provisions of Sections 65852.1 and 65852.2 of the Government Code as set forth in Section 21080.17 of the Public Resources Code.

(j) The closing of any public school or the transfer of students from that public school to another school in which kindergarten or any grades 1 through 12 is maintained as set forth in 21080.18 of the Public Resources Code.

(k) A project for restriping streets or highways to relieve traffic congestion as set forth in Section 21080.19 of the Public Resources Code.

(l) The installation of new pipeline or maintenance, repair, restoration, removal, or demolition of an existing pipeline as set forth in Section 21080.21 of the Public Resources Code, as long as the project does not exceed one mile in length.

(m) The activities and approvals by a local government necessary for the preparation of general plan amendments pursuant to Public Resources Code §29763 as set forth in Section 21080.22 of the Public Resources Code. Section 29763 of the Public Resources Code refers to local government amendments.
made for consistency with the Delta Protection Commission's regional plan.

(n) Minor alterations to utilities made for the purposes of complying with Sections 4026.7 and 4026.8 of the Health and Safety Code as set forth in Section 21080.26 of the Public Resources Code.

(o) The adoption of an ordinance exempting a city or county from the provisions of the Solar Shade Control Act as set forth in Section 25985 of the Public Resources Code.

(p) The acquisition of land by the Department of Transportation if received or acquired within a statewide or regional priority corridor designated pursuant to Section 65081.3 of the Government Code as set forth in Section 33911 of the Public Resources Code.

(q) The adoption or amendment of a non-disposal facility element as set forth in Section 41735 of the Public Resources Code.

(r) Cooperative agreements for the development of Solid Waste Management Facilities on Indian country as set forth in Section 44203(g) of the Public Resources Code.

(s) Determinations made regarding a city or county's regional housing needs as set forth in Section 65584 of the Government Code.

(t) Any action necessary to bring a general plan or relevant mandatory element of the general plan into compliance pursuant to a court order as set forth in Section 65759 of the Government Code.

(u) Industrial Development Authority activities as set forth in Section 91543 of the Government Code.

(v) Temporary changes in the point of diversion, place of use, or purpose of use due to a transfer or exchange of water or water rights as set forth in Section 1729 of the Water Code.

(w) The preparation and adoption of Urban Water Management Plans pursuant to the provisions of Section 10652 of the Water Code.

Note: Authority: Sections 21083 and 21087, Public Resources Code; References: Sections 5097.98(c), 21080.01, 21080.02, 21080.03, 21080.05, 21080.07, 21080.08, 21080.09, 21080.11, 21080.13, 21080.15, 21080.17, 21080.18, 21080.19, 21080.21, 21080.22, 21080.26, 25983, 33911, 41735, and 44203(g), Public Resources Code.

Discussion: There are numerous statutory exemptions from CEQA, not all of which can be found in CEQA itself. This section identifies many of these exemptions and provides the reader with cross references to the pertinent statutes.

15283. Housing Needs Allocation.

CEQA does not apply to regional housing needs determinations made by the Department of Housing and Community Development, a council of governments, or a city or county pursuant to Section 65584 of the Government Code.


Discussion: This section describes the statutory exemption for regional housing need allocations made prior to and during the preparation of city and county general plan housing elements.

15284. Pipelines.

(a) CEQA does not apply to any project consisting of the inspection, maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of an existing hazardous or volatile liquid pipeline.
or any valve, flange, meter, or other piece of equipment that is directly attached to the pipeline.

(b) To qualify for this exemption, the diameter of the affected pipeline must not be increased and the project must be located outside the boundaries of an oil refinery. The project must also meet all of the following criteria:

(1) The affected section of pipeline is less than eight miles in length and actual construction and excavation activities are not undertaken over a length of more than one-half mile at a time.

(2) The affected section of pipeline is not less than eight miles distance from any section of pipeline that had been subject to this exemption in the previous 12 months.

(3) The project is not solely for the purpose of excavating soil that is contaminated by hazardous materials.

(4) To the extent not otherwise required by law, the person undertaking the project has, in advance of undertaking the project, prepared a plan that will result in notification of the appropriate agencies so that they may take action, if necessary, to provide for the emergency evacuation of members of the public who may be located in close proximity to the project, and those agencies, including but not limited to the local fire department, police, sheriff, and California Highway Patrol as appropriate, have reviewed and agreed to that plan.

(5) Project activities take place within an existing right-of-way and that right-of-way will be restored to its pre-project condition upon completion of the project.

(6) The project applicant will comply with all conditions otherwise authorized by law, imposed by the city or county as part of any local agency permit process, and to comply with the Kaege-Nejedly California Wetlands Preservation Act (Public Resources Code Section 5810, et seq.), the California Endangered Species Act (Fish and Game Code Section 2050, et seq.), other applicable state laws, and all applicable federal laws.

(c) When the lead agency determines that a project meets all of the criteria of subdivisions (a) and (b), the party undertaking the project shall do all of the following:

(1) Notify in writing all responsible and trustee agencies, as well as any public agency with environmental, public health protection, or emergency response authority, of the lead agency’s invocation of this exemption.

(2) Mail notice of the project to the last known name and address of all organizations and individuals who have previously requested such notice and notify the public in the affected area by at least one of the following procedures:

(A) Publication at least one time in a newspaper of general circulation in the area affected by the proposed project. If more than one area is affected, the notice shall be published in the newspaper of largest circulation from among the newspapers of general circulation in those areas.

(B) Posting of notice on and off site in the area where the project is to be located.

(C) Direct mailing to the owners and occupants of contiguous property shown on the latest equalized assessment roll.

The notice shall include a brief description of the proposed project and its location, and the date, time, and place of any public meetings or hearings on the proposed project. This notice may be combined with the public notice required under other law, as applicable, but shall meet the preceding minimum requirements.

(3) In the case of private rights-of-way over private property, receive from the underlying property owner permission for access to the property.

(4) Immediately inform the lead agency if any soil contaminated with hazardous materials is discovered.
(5) Comply with all conditions otherwise authorized by law, imposed by the city or county as part of any local agency permit process, and to comply with the Keene-Nejedly California Wetlands Preservation Act (Public Resources Code Section 5810, et seq.), the California Endangered Species Act (Fish and Game Code Section 2050, et seq.), other applicable state laws, and all applicable federal laws.

(d) For purposes of this section, "pipeline" is used as defined in subdivision (a) of Government Code Section 51010.5. This definition includes every intrastate pipeline used for the transportation of hazardous liquid substances or highly volatile liquid substances, including a common carrier pipeline, and all piping containing those substances located within a refined products bulk loading facility which is owned by a common carrier and is served by a pipeline of that common carrier, and the common carrier owns and serves by pipeline at least five such facilities in California.


Discussion: This section describes the statutory exemption for the inspection, maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of existing hazardous or volatile liquid pipelines. The Legislature's purpose in creating this exemption was to encourage the upkeep of existing pipelines by limiting the review required of particular activities.

Subsection (b) establishes the criteria under which a pipeline project qualifies for this exemption. These include a prohibition on increasing the diameter of the existing pipeline, limitations on the length of pipeline which may be worked on at any one time, provision of an emergency notification plan to local safety agencies and the California Highway Patrol for their review and agreement, site restoration, and compliance with local, state, and federal environmental laws. Subsection (c) clarifies that the lead agency is responsible for determining that the criteria described in subsection (b) have been met. This exemption is to be invoked by the lead agency, not the project applicant. The project applicant is responsible for providing public notice, obtaining property owners' permission where the pipeline crosses private property, and complying with all regulatory requirements.

15285. Transit Agency Responses to Revenue Shortfalls.

(a) CEQA does not apply to actions taken on or after July 1, 1995 to implement budget reductions made by a publicly owned transit agency as a result of a fiscal emergency caused by the failure of agency revenues to adequately fund agency programs and facilities. Actions shall be limited to those directly undertaken by or financially supported in whole or in part by the transit agency pursuant to Section 15378(a)(1) or (2), including actions which reduce or eliminate the availability of an existing publicly owned transit service, facility, program, or activity.

(b) When invoking this exemption, the transit agency shall make a specific finding that there is a fiscal emergency. Before taking its proposed budgetary actions and making the finding of fiscal emergency, the transit agency shall hold a public hearing. After this public hearing, the transit agency shall respond within 30 days at a regular public meeting to suggestions made by the public at that initial hearing. The transit agency may make the finding of fiscal emergency only after it has responded to public suggestions.

(c) For purposes of this subdivision, "fiscal emergency" means that the transit agency is projected to have negative working capital within one year from the date that the agency finds that a fiscal emergency exists. "Working capital" is defined as the sum of all unrestricted cash, unrestricted short-term investments, and unrestricted short-term accounts receivable, minus unrestricted accounts payable. Employee retirement funds, including deferred compensation plans and Section 401(k) plans, health insurance reserves, bond payment reserves, workers' compensation reserves, and insurance reserves shall not be included as working capital.

(d) This exemption does not apply to the action of any publicly owned transit agency to reduce or eliminate a transit service, facility, program, or activity that was approved or adopted as a mitigation measure in any environmental document certified or adopted by any public agency under either CEQA or NEPA. Further, it does not apply to actions of the Los Angeles County Metropolitan Transportation

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Authority.


Discussion: This section describes the statutory exemption established for certain public transit agency budget reductions.
Article 19. Categorical Exemptions

Sections 15300 to 15332

(Note: Newly revised language is underlined; deleted language is stricken through. The numbered sections have been adopted by the Secretary of Resources as part of the California Code of Regulations. The discussions after each section are provided by the Governor's Office of Planning and Research; they are not in the California Code of Regulations.)

15300. Categorical Exemptions

Section 21084 of the Public Resources Code requires these Guidelines to include a list of classes of projects which have been determined not to have a significant effect on the environment and which shall, therefore, be exempt from the provisions of CEQA.

In response to that mandate, the Secretary for Resources has found that the following classes of projects listed in this article do not have a significant effect on the environment, and they are declared to be categorically exempt from the requirement for the preparation of environmental documents.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15300.1. Relation to Ministerial Projects

Section 21080 of the Public Resources Code exempts from the application of CEQA those projects over which public agencies exercise only ministerial authority. Since ministerial projects are already exempt, categorical exemptions should be applied only where a project is not ministerial under a public agency's statutes and ordinances. The inclusion of activities which may be ministerial within the classes and examples contained in this article shall not be construed as a finding by the Secretary for Resources that such an activity is discretionary.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15300.2. Exceptions

(a) Location. Classes 3, 4, 5, 6, and 11 are qualified by consideration of where the project is to be located -- a project that is ordinarily insignificant in its impact on the environment may in a
particularly sensitive environment be significant. Therefore, these classes are considered to apply all instances, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.

(b) Cumulative Impact. All exemptions for these classes are inapplicable when the cumulative impact of successive projects of the same type in the same place, over time is significant.

(c) Significant Effect. A categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to unusual circumstances.

(d) Scenic Highways. A categorical exemption shall not be used for a project which may result in damage to scenic resources, including but not limited to, trees, historic buildings, rock outcroppings, or similar resources, within a highway officially designated as a state scenic highway. This does not apply to improvements which are required as mitigation by an adopted negative declaration or certified EIR.

(e) Hazardous Waste Sites. A categorical exemption shall not be used for a project located on a site which is included on any list compiled pursuant to Section 65962.5 of the Government Code.

(f) Historical Resources. A categorical exemption shall not be used for a project which may cause a substantial adverse change in the significance of a historical resource.


Discussion: In McQueen v. Mid-Peninsula Regional Open Space (1988) 202 Cal. App. 3d 1136, the court reiterates that categorical exemptions are construed strictly, shall not be unreasonably expanded beyond their terms, and may not be used where there is substantial evidence that there are unusual circumstances (including future activities) resulting in (or which might reasonably result in) significant impacts which threaten the environment.

Public Resources Code Section 21084 provides several additional exceptions to the use of categorical exemptions. Pursuant to that statute, none of the following may qualify as a categorical exemption: (1) a project which may result in damage to scenic resources, including but not limited to, trees, historic buildings, rock outcroppings, or similar resources within a scenic highway (this does not apply to improvements which are required as mitigation for a project for which a negative declaration or EIR has previously been adopted or certified; (2) a project located on a site included on any list compiled pursuant to Government Code section 65962.5 (hazardous and toxic waste sites, etc.); and (3) a project which may cause a substantial adverse change in the significance of a historical resource.

15300.3. Revisions to List of Categorical Exemptions

A public agency may, at any time, request that a new class of categorical exemptions be added, or an existing one amended or deleted. This request must be made in writing to the Office of Planning and Research and shall contain detailed information to support the request. The granting of such request shall be by amendment to these Guidelines.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15300.4. Application By Public Agencies

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Each public agency shall, in the course of establishing its own procedures, list those specific activities which fall within each of the exempt classes, subject to the qualification that these lists must be consistent with both the letter and the intent expressed in the classes. Public agencies may omit from their implementing procedures classes and examples that do not apply to their activities, but they may not require EIRs for projects described in the classes and examples in this article except under the provisions of Section 15300.2.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15301. Existing Facilities

Class 1 consists of the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" itemized below are not intended to be all-inclusive of the types of projects which might fall within Class 1. The key consideration is whether the project involves negligible or no expansion of an existing use.

Examples include but are not limited to:

(a) Interior or exterior alterations involving such things as interior partitions, plumbing, and electrical conveyances;

(b) Existing facilities of both investor and publicly-owned utilities used to provide electric power, natural gas, sewerage, or other public utility services;

(c) Existing highways and streets, sidewalks, gutters, bicycle and pedestrian trails, and similar facilities (this includes road grading for the purpose of public safety);

(d) Restoration or rehabilitation of deteriorated or damaged structures, facilities, or mechanical equipment to meet current standards of public health and safety, unless it is determined that the damage was substantial and resulted from an environmental hazard such as earthquake, landslide, or flood;

(e) Additions to existing structures provided that the addition will not result in an increase of more than:

(1) 50 percent of the floor area of the structures before the addition, or 2,500 square feet, whichever is less; or

(2) 10,000 square feet if:

(A) The project is in an area where all public services and facilities are available to allow for maximum development permissible in the General Plan and

(B) The area in which the project is located is not environmentally sensitive.

(f) Addition of safety or health protection devices for use during construction of or in conjunction with existing structures, facilities, or mechanical equipment, or topographical features including navigational devices;

(g) New copy on existing on and off-premise signs;

(h) Maintenance of existing landscaping, native growth, and water supply reservoirs (excluding the use of pesticides economical poisons, as defined in Section 12753, Division 7, Chapter 2, Food and Agricultural Code California Agricultural Code);

(i) Maintenance of fish screens, fish ladders, wildlife habitat areas, artificial wildlife waterway
devices, streamflows, springs and waterholes, and stream channels (clearing of debris) to protect fish and wildlife resources;

(j) Fish stocking by the California Department of Fish and Game;

(k) Division of existing multiple family or single-family residences into common-interest ownership and subdivision of existing commercial or industrial buildings, where no physical changes occur which are not otherwise exempt;

(l) Demolition and removal of individual small structures listed in this subsection;

(1) One single-family residence. In urbanized areas, up to three single-family residences may be demolished under this exemption.

(2) A duplex or similar multifamily residential structure. In urbanized areas, this exemption applies to duplexes and similar structures where not more than six dwelling units will be demolished.

(3) A store, motel, office, restaurant, or similar small commercial structure if designed for an occupant load of 30 persons or less. In urbanized areas, the exemption also applies to the demolition of up to three such commercial buildings on sites zoned for such use.

(4) Accessory (appurtenant) structures including garages, carports, patios, swimming pools, and fences.

(m) Minor repairs and alterations to existing dams and appurtenant structures under the supervision of the Department of Water Resources.

(n) Conversion of a single family residence to office use.

(o) Installation, in an existing facility occupied by a medical waste generator, of a steam sterilization unit for the treatment of medical waste generated by that facility provided that the unit is installed and operated in accordance with the Medical Waste Management Act (Section 117600, et seq., of the Health and Safety Code) and accepts no offsite waste.

(p) Use of a single-family residence as a small family day care home, as defined in Section 1596.78 of the Health and Safety Code.


Discussion: This section describes the class of projects wherein the proposed activity will involve negligible or no expansion of the use existing at the time the exemption is granted. Application of this exemption, as all categorical exemptions, is limited by the factors described in section 15300.2. Accordingly, a project with significant cumulative impacts or which otherwise has a reasonable possibility of resulting in a significant effect does not qualify for a Class 1 exemption.

15302. Replacement or Reconstruction

Class 2 consists of replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced, including but not limited to:

(a) Replacement or reconstruction of existing schools and hospitals to provide earthquake resistant structures which do not increase capacity more than 50 percent.

(b) Replacement of a commercial structure with a new structure of substantially the same size, purpose, and capacity.

(c) Replacement or reconstruction of existing utility systems and/or facilities involving negligible or no expansion of capacity.

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(d) Conversion of overhead electric utility distribution system facilities to underground including connection to existing overhead electric utility distribution lines where the surface is restored to the condition existing prior to the undergrounding.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15303. New Construction or Conversion of Small Structures

Class 3 consists of construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. The numbers of structures described in this section are the maximum allowable on any legal parcel. Examples of this exemption include, but are not limited to:

(a) One single-family residence, or a second dwelling unit in a residential zone. In urbanized areas, up to three single-family residences may be constructed or converted under this exemption.

(b) A duplex or similar multi-family residential structure, totaling no more than four dwelling units. In urbanized areas, this exemption applies to apartments, duplexes and similar structures designed for not more than six dwelling units.

(c) A store, motel, office, restaurant or similar structure not involving the use of significant amounts of hazardous substances, and not exceeding 2500 square feet in floor area. In urbanized areas, the exemption also applies to up to four such commercial buildings not exceeding 10,000 square feet in floor area on sites zoned for such use if not involving the use of significant amounts of hazardous substances where all necessary public services and facilities are available and the surrounding area is not environmentally sensitive.

(d) Water main, sewage, electrical, gas, and other utility extensions, including street improvements, of reasonable length to serve such construction.

(e) Accessory (appurtenant) structures including garages, carports, patios, swimming pools, and fences.

(f) An accessory steam sterilization unit for the treatment of medical waste at a facility occupied by a medical waste generator, provided that the unit is installed and operated in accordance with the Medical Waste Management Act (Section 117600, et seq., of the Health and Safety Code) and accepts no offsite waste.


Discussion: This section describes the class of small projects involving new construction or conversion of existing small structures. The 1998 revisions to the section clarify the types of projects to which it applies. In order to simplify and standardize application of this section to commercial structures, the reference to occupant load of 30 persons or less contained in the prior guideline was replaced by a limit on square footage. Subsection (c) further limits the use of this exemption to those commercial projects which have available all necessary public services and facilities, and which are not located in an environmentally sensitive area.

15304. Minor Alterations to Land

Class 4 consists of minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry or agricultural purposes. Examples include, but are not limited to:
(a) Grading on land with a slope of less than 10 percent, except that grading shall not be exempt in a waterway, in any wetland, in an officially designated (by federal, state, or local government action) scenic area, or in officially mapped areas of severe geologic hazard such as an Alquist-Priolo Earthquake Fault Zone or within an official Seismic Hazard Zone, as delineated by the State Geologist.

(b) New gardening or landscaping, including the replacement of existing conventional landscaping with water efficient or fire resistant landscaping.

(c) Filling of earth into previously excavated land with material compatible with the natural features of the site.

(d) Minor alterations in land, water, and vegetation on existing officially designated wildlife management areas or fish production facilities which result in improvement of habitat for fish and wildlife resources or greater fish production;

(e) Minor temporary use of land having negligible or no permanent effects on the environment, including carnivals, sales of Christmas trees, etc;

(f) Minor trenching and backfilling where the surface is restored;

(g) Maintenance dredging where the spoil is deposited in a spoil area authorized by all applicable state and federal regulatory agencies;

(h) The creation of bicycle lanes on existing rights-of-way.

(i) Fuel management activities within 30 feet of structures to reduce the volume of flammable vegetation, provided that the activities will not result in the taking of endangered, rare, or threatened plant or animal species or significant erosion and sedimentation of surface waters. This exemption shall apply to fuel management activities within 100 feet of a structure if the public agency having fire protection responsibility for the area has determined that 100 feet of fuel clearance is required due to extra hazardous fire conditions.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: This section describes the class of projects involving minor alterations to the land. The 1998 revision to the section specified that this exemption applies to fuel management activities which will not impact threatened or endangered species or result in significant erosion or sedimentation.

15305. Minor Alterations in Land Use Limitations

Class 5 consists of minor alterations in land use limitations in areas with an average slope of less than 20%, which do not result in any changes in land use or density, including but not limited to:

(a) Minor lot line adjustments, side yard, and set back variances not resulting in the creation of any new parcel;

(b) Issuance of minor encroachment permits;

(c) Reversion to acreage in accordance with the Subdivision Map Act.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15306. Information Collection

Class 6 consists of basic data collection, research, experimental management, and resource evaluation.
activities which do not result in a serious or major disturbance to an environmental resource. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not yet approved, adopted, or funded.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15307. Actions by Regulatory Agencies for Protection of Natural Resources

Class 7 consists of actions taken by regulatory agencies as authorized by state law or local ordinance to assure the maintenance, restoration, or enhancement of a natural resource where the regulatory process involves procedures for protection of the environment. Examples include but are not limited to wildlife preservation activities of the State Department of Fish and Game. Construction activities are not included in this exemption.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15308. Actions by Regulatory Agencies for Protection of the Environment

Class 8 consists of actions taken by regulatory agencies, as authorized by state or local ordinance, to assure the maintenance, restoration, enhancement, or protection of the environment where the regulatory process involves procedures for protection of the environment. Construction activities and relaxation of standards allowing environmental degradation are not included in this exemption.


Discussion: This section reflects the ruling in International Longshoremen's and Warehousemen's Union v. Board of Supervisors, (1981) 116 Cal. App. 3d 265. That decision ruled that the use of categorical exemption Class 8 was improper for a change in a county air pollution rule that allowed a doubling of the emissions of oxides of nitrogen. The court followed the ruling in Wildlife Alive v. Chickering, (1976) 18 Cal. 3d 190 that provided that where there is a reasonable possibility that a project or activity may have a significant effect on the environment, an exemption is improper.

15309. Inspections

Class 9 consists of activities limited entirely to inspections, to check for performance of an operation, or quality, health, or safety of a project, including related activities such as inspection for possible mislabeling, misrepresentation, or adulteration of products.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15310. Loans

Class 10 consists of loans made by the Department of Veterans Affairs under the Veterans Farm and Home Purchase Act of 1943, mortgages for the purchase of existing structures where the loan will not be used for new construction and the purchase of such mortgages by financial institutions. Class 10 includes but is not limited to the following examples:

(a) Loans made by the Department of Veterans Affairs under the Veterans Farm and Home Purchase
Act of 1943.

(b) Purchases of mortgages from banks and mortgage companies by the Public Employees Retirement System and by the State Teachers Retirement System.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15311. Accessory Structures

Class 11 consists of construction, or placement of minor structures accessory to (appurtenant to) existing commercial, industrial, or institutional facilities, including but not limited to:

(a) On-premise signs;

(b) Small parking lots;

(c) Placement of seasonal or temporary use items such as lifeguard towers, mobile food units, portable restrooms, or similar items in generally the same locations from time to time in publicly owned parks, stadiums, or other facilities designed for public use.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15312. Surplus Government Property Sales

Class 12 consists of sales of surplus government property except for parcels of land located in an area of statewide, regional, or area-wide concern identified in Section 15206(b)(4). However, even if the surplus property to be sold is located in any of those areas, its sale is exempt if:

(a) The property does not have significant values for wildlife habitat or other environmental purposes, and

(b) Any of the following conditions exist:

(1) The property is of such size, shape, or inaccessibility that it is incapable of independent development or use; or

(2) The property to be sold would qualify for an exemption under any other class of categorical exemption in these Guidelines; or

(3) The use of the property and adjacent property has not changed since the time of purchase by the public agency.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: In McQueen v. Midpeninsula Regional Open Space District (1988) 202 Cal. App. 3d 1136, the court stated that the terms 'sale' and 'acquisition' are not interchangeable and reaffirmed that exemptions must comply with the "specific terms" of the exemption which are to be narrowly construed.

15313. Acquisition of Lands for Wildlife Conservation Purposes

Class 13 consists of the acquisition of lands for fish and wildlife conservation purposes including preservation of fish and wildlife habitat, establishing ecological reserves under Fish and Game Code Section 1580, and preserving access to public lands and waters where the purpose of the acquisition is
to preserve the land in its natural condition.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15314. Minor Additions to Schools

Class 14 consists of minor additions to existing schools within existing school grounds where the addition does not increase original student capacity by more than 25% or ten classrooms, whichever is less. The addition of portable classrooms is included in this exemption.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15315. Minor Land Divisions

Class 15 consists of the division of property in urbanized areas zoned for residential, commercial, or industrial use into four or fewer parcels when the division is in conformance with the General Plan and zoning, no variances or exceptions are required, all services and access to the proposed parcels to local standards are available, the parcel was not involved in a division of a larger parcel within the previous 2 years, and the parcel does not have an average slope greater than 20 percent.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15316. Transfer of Ownership of Land in Order to Create Parks

Class 16 consists of the acquisition, sale, or other transfer of land in order to establish a park where the land is in a natural condition or contains historical or archaeological resources and either:

(a) The management plan for the park has not been prepared, or

(b) The management plan proposes to keep the area in a natural condition or preserve the historic or archaeological resources. CEQA will apply when a management plan is proposed that will change the area from its natural condition or cause substantial adverse change in the significance of the historic or archaeological resource.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21084, 21083.2, and 21084.1, Public Resources Code.

Discussion: In McQueen v. Midpeninsula Regional Open Space District (1988) 202 Cal. App. 3d 1136, the court ruled that the taking or acquiring property "as-is" does not constitute a "natural condition" when there is substantial evidence in the record that hazardous waste has been upon it.

15317. Open Space Contracts or Easements

Class 17 consists of the establishment of agricultural preserves, the making and renewing of open space contracts under the Williamson Act, or the acceptance of easements or fee interests in order to maintain the open space character of the area. The cancellation of such preserves, contracts, interests, or easements is not included and will normally be an action subject to the CEQA process.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15318. Designation of Wilderness Areas
Class 18 consists of the designation of wilderness areas under the California Wilderness System.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15319. Annexations of Existing Facilities and Lots for Exempt Facilities

Class 19 consists of only the following annexations:

(a) Annexations to a city or special district of areas containing existing public or private structures developed to the density allowed by the current zoning or pre-zoning of either the gaining or losing governmental agency whichever is more restrictive, provided, however, that the extension of utility services to the existing facilities would have a capacity to serve only the existing facilities.

(b) Annexations of individual small parcels of the minimum size for facilities exempted by Section 15303, New Construction or Conversion of Small Structures.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: The exemption under subsection (a) is not allowed if it is foreseeable that utility services would extend into the annexed parcels and have the potential to serve a greater capacity than existing uses. The exemption is also unavailable if "unusual circumstances" under Section 15300.2(c) are found. For example, in City of Santa Clara v. LAFCO of Santa Clara County, (1983) 139 Cal. App. 3d 923, the court found that unusual circumstances existed when the annexing city's general plan called for the newly annexed parcels to eventually become residential and industrial rather than the prozoned agricultural use. The unusual circumstances arose from the inconsistency between the prozoned agricultural use and the general plan's designated land use and thus precluded the use of this categorical exemption.

15320. Changes in Organization of Local Agencies

Class 20 consists of changes in the organization or reorganization of local governmental agencies where the changes do not change the geographical area in which previously existing powers are exercised. Examples include but are not limited to:

(a) Establishment of a subsidiary district;

(b) Consolidation of two or more districts having identical powers;

(c) Merger with a city of a district lying entirely within the boundaries of the city.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15321. Enforcement Actions by Regulatory Agencies

Class 21 consists of:

(a) Actions by regulatory agencies to enforce or revoke a lease, permit, license, certificate, or other entitlement for use issued, adopted, or prescribed by the regulatory agency or enforcement of a law, general rule, standard, or objective, administered or adopted by the regulatory agency. Such actions include, but are not limited to, the following:

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(1) The direct referral of a violation of lease, permit, license, certificate, or entitlement for use or of a general rule, standard, or objective to the Attorney General, District Attorney, or City Attorney as appropriate, for judicial enforcement;

(2) The adoption of an administrative decision or order enforcing or revoking the lease, permit, license, certificate, or entitlement for use or enforcing the general rule, standard, or objective.

(b) Law enforcement activities by peace officers acting under any law that provides a criminal sanction;

(c) Construction activities undertaken by the public agency taking the enforcement or revocation action are not included in this exemption.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: The exemption for law enforcement activities by peace officers acting under any law that provides a criminal sanction is based largely on the rationale explained by the court in *Pacific Water Conditioning Association v. City Council*, (1977) 73 Cal. App. 3d 546. There the court noted that enforcement actions are taken long after the public agency, or possibly the State Legislature, has exercised its discretion to set standards governing a certain kind of activity.

15322. Educational or Training Programs Involving No Physical Changes

Class 22 consists of the adoption, alteration, or termination of educational or training programs which involve no physical alteration in the area affected or which involve physical changes only in the interior of existing school or training structures. Examples include but are not limited to:

(a) Development of or changes in curriculum or training methods.

(b) Changes in the grade structure in a school which do not result in changes in student transportation.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15323. Normal Operations of Facilities for Public Gatherings

Class 23 consists of the normal operations of existing facilities for public gatherings for which the facilities were designed, where there is a past history of the facility being used for the same or similar kind of purpose. For the purposes of this section, "past history" shall mean that the same or similar kind of activity has been occurring for at least three years and that there is a reasonable expectation that the future occurrence of the activity would not represent a change in the operation of the facility. Facilities included within this exemption include, but are not limited to, racetracks, stadiums, convention centers, auditoriums, amphitheaters, planetariums, swimming pools, and amusement parks.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: This section clarifies what is meant by the term "a past history of the facility being used for the same kind of purpose." The section relates the concept of past history to public expectations for use of the facility in the future. Where the facility has been used for a particular purpose for several years and people expect the use to continue in the future, continuation of that use would not represent a change in the environmental conditions. For example, if a county fair had included a stock car racing meet for each of three consecutive years, people living in the area would have come to expect that the county fair would involve stock car racing in the future. Continuing racing activity would not represent a substantial change in the environment from what people had come to expect. However, in *Lewis v. 17th District Agricultural Ass'n* (1985) 165 Cal. App. 3d 823, the court found that the
existence of residential areas near a racetrack constituted "unusual circumstances" (Guidelines section 15300.2 (c)) which removed the racing activity from the exemption. Additionally, the court found that imposing mitigation measures to offset the possible significant adverse change in the environment caused by the activity will not cause the exemption to be applicable unless the mitigation measures result in the elimination of the possibility of a significant adverse change in the environment. The decision to allow stock car racing at a county fair in the first place could well call for some kind of CEQA analysis before starting that activity. Once the activity has been established, however, continuing the activity does not represent a change, and absent a significant change in the use and absent the existence of unusual circumstances. Concerning what are considered normal operations of facilities for public gatherings see Campbell v. Third District Agricultural Association (1987) 195 Cal.App. 3d 115.

15324. Regulations of Working Conditions

Class 24 consists of actions taken by regulatory agencies, including the Industrial Welfare Commission as authorized by statute, to regulate any of the following:

(a) Employee wages,

(b) Hours of work, or

(c) Working conditions where there will be no demonstrable physical changes outside the place of work.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15325. Transfers of Ownership of Interest In Land to Preserve Existing Natural Conditions and Historical Resources

Class 25 consists of transfers of ownership in interests in land in order to preserve open space, habitat, or historical resources. Examples include but are not limited to:

(a) Acquisition, sale, or other transfer of areas to preserve existing natural conditions, including plant or animal habitats.

(b) Acquisition, sale, or other transfer of areas to allow continued agricultural use of the areas.

(c) Acquisition, sale, or other transfer to allow restoration of natural conditions, including plant or animal habitats.

(d) Acquisition, sale, or other transfer to prevent encroachment of development into flood plains.

(e) Acquisition, sale, or other transfer to preserve historical resources.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

Discussion: In McQueen v. Midpeninsula Regional Open Space District (1988) 202 Cal. App. 3d 1136, stated that the terms 'sale' and 'acquisition' are not interchangeable and reaffirmed that exemptions must comply with the "specific terms" of the exemption which are to be narrowly construed.

The class of project described by this section consists of transfers of ownership that are made to preserve open space, habitat, or historical resources. The 1998 revisions to this section clarify that sale or other transfer of lands is included among the exempt activities. Use of this exemption, like all categorical exemptions, is limited by the factors described in section 15300.2.
15326. Acquisition of Housing for Housing Assistance Programs

Class 26 consists of actions by a redevelopment agency, housing authority, or other public agency to implement an adopted Housing Assistance Plan by acquiring an interest in housing units. The housing units may be either in existence or possessing all required permits for construction when the agency makes its final decision to acquire the units.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15327. Leasing New Facilities

(a) Class 27 consists of the leasing of a newly constructed or previously unoccupied privately owned facility by a local or state agency where the local governing authority determined that the building was exempt from CEQA. To be exempt under this section, the proposed use of the facility:

(1) Shall be in conformance with existing state plans and policies and with general, community, and specific plans for which an EIR or Negative Declaration has been prepared;

(2) Shall be substantially the same as that originally proposed at the time the building permit was issued;

(3) Shall not result in a traffic increase of greater than 10% of front access road capacity; and

(4) Shall include the provision of adequate employee and visitor parking facilities.

(b) Examples of Class 27 include, but are not limited to:

(1) Leasing of administrative offices in newly constructed office space;

(2) Leasing of client service offices in newly constructed retail space;

(3) Leasing of administrative and/or client service offices in newly constructed industrial parks.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15328. Small Hydroelectric Projects at Existing Facilities

Class 28 consists of the installation of hydroelectric generating facilities in connection with existing dams, canals, and pipelines where:

(a) The capacity of the generating facilities is 5 megawatts or less;

(b) Operation of the generating facilities will not change the flow regime in the affected stream, canal, or pipeline including but not limited to:

(1) Rate and volume of flow;

(2) Temperature;

(3) Amounts of dissolved oxygen to a degree that could adversely affect aquatic life; and

(4) Timing of release.

(c) New power lines to connect the generating facilities to existing power lines will not exceed one mile in length if located on a new right of way and will not be located adjacent to a wild or scenic...
river;

(d) Repair or reconstruction of the diversion structure will not raise the normal maximum surface elevation of the impoundment;

(e) There will be no significant upstream or downstream passage of fish affected by the project;

(f) The discharge from the power house will not be located more than 300 feet from the toe of the diversion structure;

(g) The project will not cause violations of applicable state or federal water quality standards;

(h) The project will not entail any construction on or alteration of a site included in or eligible for inclusion in the National Register of Historic Places; and

(i) Construction will not occur in the vicinity of any endangered, rare, or threatened species.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15329. Cogeneration Projects at Existing Facilities

Class 29 consists of the installation of cogeneration equipment with a capacity of 50 megawatts or less at existing facilities meeting the conditions described in this section.

(a) At existing industrial facilities, the installation of cogeneration facilities will be exempt where it will:

(1) Result in no net increases in air emissions from the industrial facility, or will produce emissions lower than the amount that would require review under the new source review rules applicable in the county, and

(2) Comply with all applicable state, federal, and local air quality laws.

(b) At commercial and institutional facilities, the installation of cogeneration facilities will be exempt if the installation will:

(1) Meet all the criteria described in subsection (a);

(2) Result in no noticeable increase in noise to nearby residential structures;

(3) Be contiguous to other commercial or institutional structures.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21084, Public Resources Code.

15330. Minor Actions to Prevent, Minimize, Stabilize, Mitigate or Eliminate the Release or Threat of Release of Hazardous Waste or Hazardous Substances.

Class 30 consists of any minor cleanup actions taken to prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a hazardous waste or substance which are small or medium removal actions costing $1 million or less. No cleanup action shall be subject to this Class 30 exemption if the action requires the onsite use of a hazardous waste incinerator or thermal treatment unit, with the exception of low temperature thermal desorption, or the relocation of residences or businesses, or the action involves the potential release into the air of volatile organic compounds as defined in Health and Safety Code section 25123.6, except for small scale in situ soil vapor extraction
and treatment systems which have been permitted by the local Air Pollution Control District or Air Quality Management District. All actions must be consistent with applicable state and local environmental permitting requirements including, but not limited to, air quality rules such as those governing volatile organic compounds and water quality standards, and approved by the regulatory body with jurisdiction over the site. Examples of such minor cleanup actions include but are not limited to:

(a) Removal of sealed, non-leaking drums or barrels of hazardous waste or substances that have been stabilized, containerized and are designated for a lawfully permitted destination;

(b) Maintenance or stabilization of berms, dikes, or surface impoundments;

(c) Construction or maintenance of interim or temporary surface caps;

(d) Onsite treatment of contaminated soils or sludges provided treatment system meets Title 22 requirements and local air district requirements;
(e) Excavation and/or offsite disposal of contaminated soils or sludges in regulated units;

(f) Application of dust suppressants or dust binders to surface soils;

(g) Controls for surface water run-on and run-off that meets seismic safety standards;

(h) Pumping of leaking ponds into an enclosed container;

(i) Construction of interim or emergency ground water treatment systems;

(j) Posting of warning signs and fencing for a hazardous waste or substance site that meets legal requirements for protection of wildlife.


Discussion: This defines certain minor hazardous waste or hazardous substances cleanup actions as a class of exempt projects. This exemption is intended to speed such cleanups, while at the same time providing sufficient safeguards to ensure that no significant environmental effects may occur as a result. Application of this exemption, as all categorical exemptions, is limited by the factors described in section 15300.2.

15331. Historical Resource Restoration/Rehabilitation.

Class 31 consists of projects limited to maintenance, repair, stabilization, rehabilitation, restoration, preservation, conservation or reconstruction of historical resources in a manner consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995), Weeks and Grimmer.


Discussion: This section establishes an exemption for projects involving the maintenance, rehabilitation, restoration, preservation, or reconstruction of historical resources, provided that the activity meets published federal standards for the treatment of historic properties. These federal standards describe means of preserving, rehabilitating, restoring, and reconstructing historic buildings without adversely affecting their historic significance. Use of this exemption, like all categorical exemptions, is limited by the factors described in section 15300.2 and is not to be used where the activity would cause a substantial adverse change in the significance of a historical resource.

15332. In-Fill Development Projects.
Class 32 consists of projects characterized as in-fill development meeting the conditions described in this section.

(a) The project is consistent with the applicable general plan designation and all applicable general plan policies as well as with applicable zoning designation and regulations.

(b) The proposed development occurs within city limits on a project site of no more than five acres substantially surrounded by urban uses.

(c) The project site has no value as habitat for endangered, rare or threatened species.

(d) Approval of the project would not result in any significant effects relating to traffic, noise, air quality, or water quality.

(e) The site can be adequately served by all required utilities and public services.


Discussion: This section is intended to promote infill development within urbanized areas. The class consists of environmentally benign infill projects which are consistent with local general plan and zoning requirements. This class is not intended to be applied to projects which would result in any significant traffic, noise, air quality, or water quality effects. Application of this exemption, as all categorical exemptions, is limited by the factors described in section 15300.2.
Title 14. California Code of Regulations
Chapter 3. Guidelines for Implementation of the
California Environmental Quality Act

Article 20. Definitions

Sections 15350 to 15387

15350. General

The definitions contained in this article apply to terms used throughout the Guidelines unless a term is otherwise defined in a particular section.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21083, Public Resources Code.

15351. Applicant

"Applicant" means a person who proposes to carry out a project which needs a lease, permit, license, certificate, or other entitlement for use or financial assistance from one or more public agencies when that person applies for the governmental approval or assistance.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21085, Public Resources Code.

Discussion: This section defines a term used frequently in the Guidelines to refer to a person who applies to a public agency for a lease, permit, license, certificate, or other entitlement in the Guidelines apply only to applicants and not to governmental agencies that carry out projects directly.

15352. Approval

(a) "Approval" means the decision by a public agency which commits the agency to a definite course of action in regard to a project intended to be carried out by any person. The exact date of approval of any project is a matter determined by each public agency according to its rules, regulations, and ordinances. Legislative action in regard to a project often constitutes approval.

(b) With private projects, approval occurs upon the earliest commitment to issue or the issuance by the public agency of a discretionary contract, grant, subsidy, loan, or other form of financial assistance, lease, permit, license, certificate, or other entitlement for use of the project.
Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21061 and 21065, Public Resources Code.

Discussion: The term "approval" needs definition because the term is critical to the CEQA process. A public agency must comply with CEQA when the agency proposes to approve some kind of project. The statute does not define the term, and it is often difficult to identify the time when the project is approved. This section spells out criteria for determining when the approval occurs.

15353. CEQA

"CEQA" means the California Environmental Quality Act, California Public Resources Code Sections 21000 et seq.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21050, Public Resources Code.

15354. Categorical Exemption

"Categorical exemption" means an exemption from CEQA for a class of projects based on a finding by the Secretary for Resources that the class of projects does not have a significant effect on the environment.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080 (b)(10) and 21084, Public Resources Code.

Discussion: This section provides a simple term and definition to apply to the administrative exemptions from CEQA established by the Secretary for Resources under Section 21084 in CEQA. These exemptions apply to classes of projects for which the Secretary for Resources has made a finding that the class of projects will not have a significant effect on the environment.

15355. Cumulative Impacts

"Cumulative impacts" refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.

(a) The individual effects may be changes resulting from a single project or a number of separate projects.

(b) The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.


Discussion: The definition of the term "cumulative impacts" is provided because the term is related to one of the mandatory findings of significant effect required by Section 21083. A common understanding of the term is needed in order to implement the section. Further, this definition is needed to codify the court rulings in Whitman v. Board of Supervisors and San Franciscans for Reasonable Growth v. City and County of San Francisco.

15356. Decision-Making Body
"Decision-making body" means any person or group of people within a public agency permitted by law to approve or disapprove the project at issue.


Discussion: This definition is added because there is a need for a term to apply to the person or group which has authority to make the decision to approve or carry out a project. The individuals or groups which are granted this authority seem to have no one common name or common description among the many agencies subject to CEQA. Accordingly, the Guidelines must provide a term which could apply to these people in all situations.

15357. Discretionary Project

"Discretionary project" means a project which requires the exercise of judgment or deliberation when the public agency or body decides to approve or disapprove a particular activity, as distinguished from situations where the public agency or body merely has to determine whether there has been conformity with applicable statutes, ordinances, or regulations. A timber harvesting plan submitted to the state forester for approval under the requirements of the Z'berg-Nejedly Forest Practice Act of 1973 (Pub. Res. Code Sections 4511 et seq.) constitutes a discretionary project within the meaning of the California Environmental Quality Act. Section 21065(c).


Discussion: A definition of the term "discretionary project" is essential for defining the scope of activities subject to CEQA. The Act provides that it applies to discretionary projects, but the Act does not define the term. The definition offered here is taken from the State Supreme Court decision in Johnson v. State of California, a 1968 decision. The definition in this section has been approved in a number of court decisions since that time. Several of these decisions are cited in the note. See also discussion for Section 15368.

15358. Effects

"Effects" and "impacts" as used in these Guidelines are synonymous.

(a) Effects include:

(1) Direct or primary effects which are caused by the project and occur at the same time and place.

(2) Indirect or secondary effects which are caused by the project and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect or secondary effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

(b) Effects analyzed under CEQA must be related to a physical change.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21068 and 21100, Public Resources Code.

Discussion: Confusion has arisen in interpreting CEQA because the law uses the terms "effects" and "impacts" without making clear whether the words have different or identical meanings. This section is intended to eliminate that confusion and to use the federal definition of the term from the NEPA
regulations to the extent that the statutes are similar. Subsection (a) is identical to part of Section 1508.8 in the NEPA regulations, but subsection (b) is different because CEQA is more focused on physical changes than is NEPA.

15359. Emergency

"Emergency" means a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to life, health, property, or essential public services. Emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (b)(2), (3), and (4), Public Resources Code.

Discussion: The definition of the term "emergency" was originally developed in these Guidelines. Later legislation added the definition to the statute.

15360. Environment

"Environment" means the physical conditions which exist within the area which will be affected by a proposed project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance. The area involved shall be the area in which significant effects would occur either directly or indirectly as a result of the project. The "environment" includes both natural and man-made conditions.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21060.5, Public Resources Code.

Discussion: This definition combines statutory language in the first sentence with administrative interpretation in the second and third sentences.

15361. Environmental Documents

"Environmental documents" means Initial Studies, Negative Declarations, draft and final EIRs, documents prepared as substitutes for EIRs and Negative Declarations under a program certified pursuant to Public Resources Code Section 21080.5, and documents prepared under NEPA and used by a state or local agency in the place of an Initial Study, Negative Declaration, or an EIR.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21061, 21080(b), 21080.5, 21108, and 21152, Public Resources Code.

Discussion: The term "environmental documents" is intended to provide a shorthand way of referring to all the documents listed in the definition.

15362. EIR - Environmental Impact Report

"EIR" or "Environmental Impact Report" means a detailed statement prepared under CEQA describing describing and analyzing the significant environmental effects of a project and discussing ways to mitigate or avoid the effects. The contents of an EIR are discussed in Article 9, commencing with Section 15120 of these Guidelines. The term "EIR" may mean either a draft or a final EIR depending on the context.

(a) Draft EIR means an EIR containing the information specified in Sections 15122 through 15131.

(b) Final EIR means an EIR containing the information contained in the draft EIR, comments either
verbatim or in summary received in the review process, a list of persons commenting, and the
response of the Lead Agency to the comments received. The final EIR is discussed in detail in Section
15132.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21061,
21100, and 21151, Public Resources Code.

Discussion: This section identifies the abbreviation "EIR" and provides a short definition of the term
"Environmental Impact Report" although the term "Environmental Impact Report" is defined in detail
with a number of other requirements in Section 21061 of the statute. This section provides a more
focused definition and introduces the terms "draft EIR" and "final EIR."

15363. EIS - Environmental Impact Statement

"EIS" or "Environmental Impact Statement" means an environmental impact document prepared
pursuant to the National Environmental Policy Act (NEPA). NEPA uses the term EIS in the place of
the term EIR which is used in CEQA.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections

Discussion: This section introduces the abbreviation "EIS" and provides a short definition of the term
"Environmental Impact Statement." This definition is needed because CEQA and the Guidelines refer
to EISs in many places where the CEQA process may involve overlaps with NEPA.

15364. Feasible

"Feasible" means capable of being accomplished in a successful manner within a reasonable period of
time, taking into account economic, environmental, legal, social, and technological factors.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21002,
21002.1, 21004, 21061.1, 21080.5, and 21081, Public Resources Code; Section 4, Chapter 1438 of the
Statutes of 1982.

Discussion: This section provides an additional interpretation of the statutory language by adding the
word "legal" to the statutory language. The legal limitation is incorporated in the concept of feasibility
as it applies to the findings an agency must make concerning whether to mitigate or avoid significant
effects identified in an EIR. The lack of legal powers of an agency to use in imposing an alternative or
mitigation measure may be as great a limitation as any economic, environmental, social, or
 technological factor.

15365. Initial Study

"Initial Study" means a preliminary analysis prepared by the Lead Agency to determine whether an
EIR or a Negative Declaration must be prepared or to identify the significant environmental effects to
be analyzed in an EIR. Use of the Initial Study is discussed in Article 5, commencing with Section
15060.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections
21080.1, 21080.2, 21080.3, and 21100, Public Resources Code.

Discussion: This definition is added to define a term which is created in these Guidelines.

15366. Jurisdiction by Law

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(a) "Jurisdiction by law" means the authority of any public agency:

(1) To grant a permit or other entitlement for use;

(2) To provide funding for the project in question; or

(3) To exercise authority over resources which may be affected by the project.

(b) A city or county will have jurisdiction by law with respect to a project when the city or county having primary jurisdiction over the area involved is:

(1) The site of the project;

(2) The area in which the major environmental effects will occur, and/or

(3) The area in which reside those citizens most directly concerned by any such environmental effects.

(c) Where an agency having jurisdiction by law must exercise discretionary authority over a project in order for the project to proceed, it is also a Responsible Agency, see Section 15381, or the Lead Agency, see Section 15367.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.3, 21080.4, 21104, and 21153, Public Resources Code.

Discussion: This section defines the term "jurisdiction by law" in order to establish which agencies must be consulted by the Lead Agency in preparing an EIR. The statute does not define this term.

15367. Lead Agency

"Lead Agency" means the public agency which has the principal responsibility for carrying out or approving a project. The Lead Agency will decide whether an EIR or Negative Declaration will be required for the project and will cause the document to be prepared. Criteria for determining which agency will be the Lead Agency for a project are contained in Section 15051.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21165, Public Resources Code.

Discussion: This section combines the statutory definition of the term "Lead Agency" with a more complete explanation in terms related to the CEQA process. The fundamental point is that CEQA gives the Lead Agency the tasks of determining whether an EIR or a Negative Declaration will be required for the project and preparing the document.

15368. Local Agency

"Local agency" means any public agency other than a state agency, board, or commission. Local agency includes but is not limited to cities, counties, charter cities and counties, districts, school districts, special districts, redevelopment agencies, local agency formation commissions, and any board, commission, or organizational subdivision of a local agency when so designated by order or resolution of the governing legislative body of the local agency.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21062 and 21151, Public Resources Code.

Discussion: This section supplements the definition of the term "local agency" contained in the Public Resources Code to recognize the possibility that a city may designate a particular sub-unit of the city government as being a separate Lead Agency for a particular project. In this situation, the subunit would qualify as a local agency under these Guidelines, and all the requirements placed on a local agency would apply to that unit.

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An agency created by state statute such as an agricultural district may be considered a local agency for the purposes of CEQA even though it may be considered a state agency for other purposes; this is possible because the agency's activities are most likely to affect only the local area in which it operates. (Sec. Lewis v. 17th District Agricultural Ass'n. (1985) 165 Cal. App. 3d 823. Agencies should be aware that the notice and filing requirements stated either in Sections 21150 et seq. or Sections 21100 et seq. of CEQA may apply depending upon whether the agency is defined as "state" or "local" for CEQA purposes.

15369. Ministerial

"Ministerial" describes a governmental decision involving little or no personal judgment by the public official as to the wisdom or manner of carrying out the project. The public official merely applies the law to the facts as presented but uses no special discretion or judgment in reaching a decision. A ministerial decision involves only the use of fixed standards or objective measurements, and the public official cannot use personal, subjective judgment in deciding whether or how the project should be carried out. Common examples of ministerial permits include automobile registrations, dog licenses, and marriage licenses. A building permit is ministerial if the ordinance requiring the permit limits the public official to determining whether the zoning allows the structure to be built in the requested location, the structure would meet the strength requirements in the Uniform Building Code, and the applicant has paid his fee.


Discussion: This definition draws upon earlier judicial definitions of "ministerial" and discretionary governmental actions and provides examples. Neither term is technically precise.

As carefully pointed out in Friends of Westwood, Inc. v. Los Angeles (1987) 191 Cal. App. 3d 259, usually building permits are ministerial but the approval process for a project unusual in size, dimension and location involve discretionary aspects which are subject to CEQA; it is enough the [agency] possesses discretion to require changes which would mitigate in whole or in part one or more of the [significant] environmental consequences an EIR might conceivably uncover. See also discussion for Section 15268.

15369.5. Mitigated Negative Declaration

"Mitigated negative declaration" means a negative declaration prepared for a project when the initial study has identified potentially significant effects on the environment, but (1) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (2) there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21064.5, Public Resources Code.

15370. Mitigation

"Mitigation" includes:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
(c) Rectifying the impact by repairing, rehabilitating, or restoring the impacted environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing or providing substitute resources or environments.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21002, 21002.1, 21081, and 21100(c), Public Resources Code.

Discussion: This definition of the term "mitigation" adopts the definition contained in the federal NEPA regulations. The federal definition is used so that this term will have identical meanings under NEPA and CEQA for projects which are subject to both acts.

15371. Negative Declaration

"Negative Declaration" means a written statement by the Lead Agency briefly describing the reasons that a proposed project, not exempt from CEQA, will not have a significant effect on the environment and therefore does not require the preparation of an EIR. The contents of a Negative Declaration are described in Section 15071.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080 (c), Public Resources Code.

Discussion: This definition is added in order to provide a clear, short identification of the term "Negative Declaration." The section identifies four essential concepts dealing with the document: First, the Negative Declaration applies to projects which are not exempt. Second, the document must be written and provide a brief explanation of its conclusion. Third, the document is used where the agency concludes that the project will not have a significant effect on the environment. Fourth, the document serves as a statement that the agency will not prepare an EIR, but the statement is used only where it is based on a finding that the project will not cause a significant effect on the environment.

15372. Notice of Completion

"Notice of Completion" means a brief notice filed with OPR by a Lead Agency as soon as it has completed a draft EIR and is prepared to send out copies for review. The contents of this notice are explained in Section 15085.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21161, Public Resources Code.

Discussion: This section defines the term "Notice of Completion" to provide a commonly used and recognized term for the notice which the statute requires a Lead Agency to file when an EIR has been completed.

15373. Notice of Determination

"Notice of Determination" means a brief notice to be filed by a public agency after it approves or determines to carry out a project which is subject to the requirements of CEQA. The contents of this notice are explained in Sections 15075 and 15094.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21108 (a) and 21152, Public Resources Code.

Discussion: This section defines the term "Notice of Determination" to provide a commonly used and recognized term for the notice which the statute requires an agency to file after it has approved the project at the end of the CEQA process. One cross-reference describes the contents of the notice when
used with a Negative Declaration. The other describes the contents after an EIR has been prepared.

15374. Notice of Exemption

"Notice of Exemption" means a brief notice which may be filed by a public agency after it has decided to carry out or approve a project and has determined that the project is exempt from CEQA as being ministerial, categorically exempt, an emergency, or subject to another exemption from CEQA. Such a notice may also be filed by an applicant where such a determination has been made by a public agency which must approve the project. The contents of this notice are explained in Section 15062.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21108 (b) and 21152(b), Public Resources Code.

Discussion: This section provides a definition for the notice which an agency is authorized to file when it determines that a particular project is exempt from the requirements of CEQA. The statute authorizes the use of this notice but does not provide a name or detailed explanation for it.

15375. Notice of Preparation

"Notice of Preparation" means a brief notice sent by a Lead Agency to notify the Responsible Agencies, Trustee Agencies, and involved federal agencies that the Lead Agency plans to prepare an EIR for the project. The purpose of the notice is to solicit guidance from those agencies as to the scope and content of the environmental information to be included in the EIR. Public agencies are free to develop their own formats for this notice. The contents of this notice are described in Section 15082.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21080.4, Public Resources Code.

Discussion: This definition provides a commonly used and easily recognizable name for the notice which a Lead Agency is required to send to Responsible Agencies to obtain the views of Responsible Agencies on the contents of an EIR which the Lead Agency will prepare. The reference to federal agencies was added because Section 15082 requires this notice to be sent to federal agencies.

15376. Person

"Person" includes any person, firm, association, organization, partnership, business, trust, corporation, limited liability company, company, district, city, county, city and county, town, the state, and any of the agencies or political subdivisions of such entities.

Note: Authority cited. Sections 21083 and 21087, Public Resources Code; Reference: Section 21066, Public Resources Code.

Discussion: This definition indicates the broad scope of the term "person" as used in CEQA. This term is used in a number of different places in the Guidelines and the statute in ways that require use of such a broad definition. Legislation enacted in 1998 specifies that "person" includes federal agencies to the extent permitted by federal law (AB 2397 -- Chapter 272, Statutes of 1998). This addition is pertinent where federal law has delegated regulatory responsibility for actions on federal land or by federal agencies to the state.

15377. Private Project

A "private project" means a project which will be carried out by a person other than a governmental agency, but the project will need a discretionary approval from one or more governmental agencies for:
(a) A contract or financial assistance, or

(b) A lease, permit, license, certificate, or other entitlement for use.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21065,
Public Resources Code.

Discussion: This section defines a term to be used in the place of a much longer phrase several places
in the statute. In a number of different contexts, the statute sets up special requirements that apply by
way of a cross-reference to activities which involve the issuance of a lease, license, certificate, permit,
or other entitlement for use. It is clearer in these situations to refer to private projects.

15378. Project

(a) "Project" means the whole of an action, which has a potential for resulting in either a direct
physical change in the environment, or a reasonably foreseeable indirect physical change in the
environment, and that is any of the following:

(1) An activity directly undertaken by any public agency including but not limited to public works
construction and related activities clearing or grading of land, improvements to existing public
structures, enactment and amendment of zoning ordinances, and the adoption and amendment of local
General Plans or elements thereof pursuant to Government Code Sections 65100-65700.

(2) An activity undertaken by a person which is supported in whole or in part through public agency
contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.

(3) An activity involving the issuance to a person of a lease, permit, license, certificate, or other
entitlement for use by one or more public agencies.

(b) Project does not include:

(1) Proposals for legislation to be enacted by the State Legislature;

(2) Continuing administrative or maintenance activities, such as purchases for supplies, personnel-
related actions, general policy and procedure making (except as they are applied to specific instances
covered above);

(3) The submittal of proposals to a vote of the people of the state or of a particular community. (Stein
v. City of Santa Monica (1980) 110 Cal.App.3d 458);

(4) The creation of government funding mechanisms or other government fiscal activities, which do
not involve any commitment to any specific project which may result in a potentially significant
physical impact on the environment.

(5) Organizational or administrative activities of governments which are political or which are not
physical changes in the environment (such as the reorganization of a school district or detachment of
park land).

(c) The term "project" refers to the activity which is being approved and which may be subject to
several discretionary approvals by governmental agencies. The term "project" does not mean each
separate governmental approval.

(d) Where the Lead Agency could describe the project as either the adoption of a particular regulation
under subsection (a)(1) or as a development proposal which will be subject to several governmental
approvals under subsections (a)(2) or (a)(3), the Lead Agency shall describe the project as the
development proposal for the purpose of environmental analysis. This approach will implement the
Lead Agency principle as described in Article 4.

Note: Authority: Sections 21083 and 21087, Public Resources Code; Reference: Section 21065,
Public Resources Code; Kaufman and Broad—South Bay, Inc. v. Morgan Hill Unified School District

Discussion: This section provides a more complete explanation of the term "project." This term describes activities which are subject to CEQA. This definition brings together a number of separate provisions in the Act. These are the definition of the term contained in Section 21065 of the statute, the Lead Agency concept in Section 21165 of the statute, and the result of a number of court decisions interpreting this term. Chapter 1230 of the Statutes of 1994 codifies the emphasis on "physical change" in the environment.

Following the State Supreme Court's decision in Friends of Mammoth, the Legislature added a definition of the term "project" to the statute. The definition provided that "project" meant activities directly undertaken by government, activities financed by government, or activities requiring a permit or other approval from government. The Legislature then added the words "or approve" to the section requiring that agencies shall prepare an EIR "on any project they proposed to carry out or approve which may have a significant effect on the environment."

Reading the language of Sections 21065 and 21100 together, the project which is to be analyzed in the EIR is not the approval itself but is that which is being approved.

With some activities carried out by government, the plan, control, or regulation being adopted may need to be regarded as the project even though the plan, etc., is being adopted to control activities to be initiated later by other people. For example, in approving a new general plan for a city, the city council would properly regard the general plan itself as the project. The EIR would examine the environmental changes that would probably result from adopting the new plan. In this situation, the governmental plan would not be proposed in conjunction with a proposal for a specific development project, and the EIR on the plan would need to examine the range of possible effects of the plan. If, however, a small amendment to the general plan was requested as one of several approvals necessary for a specific development project, the city should characterize the proposed development as the project. In this way, the city would implement the Lead Agency concept by designating as the project the activity which would be approved by a number of agencies. This approach would result in only one EIR being prepared for the proposed development as required by Sections 21165 and 21166 of CEQA.

In Livermore v. Local Agency Formation Commission of Alameda County (1986) 184 Cal. App. 3d 531/(1986) 183 Cal. App. 3d. 681, the court ruled that LAFCO's guideline revisions fit within CEQA's broad definition of a project because they are a discretionary activity of a public agency that will unquestionably have an ultimate impact on the environment, i.e., major policy decisions that determine whether growth will occur in unincorporated areas and whether agricultural land will be preserved or developed.

However, in marked contrast, Northwood Homes, Inc. v. Moraga (1989) 216 Cal. App. 3d 1197 concluded that general guidelines enacted as administrative activities for procedural implementation as to definitions of terms and application procedures of land use decisions are not a project.

Items (4) and (5) under subsection (b) codify the decisions in Kaufman and Broad-South Bay, Inc. v. Morgan Hill Unified School District (1992) 9 Cal. App. 4th 464 and Simi Valley Recreation and Park District v. Local Agency Formation Commission of Ventura County (1975) 51 Cal. App. 3d 648 which clarify that CEQA does not apply to activities which do not result, either directly or in a reasonably foreseeable indirect way, in a physical change to the environment.

15379. Public Agency

"Public agency" includes any state agency, board, or commission and any local or regional agency, as defined in these Guidelines. It does not include the courts of the state. This term does not include agencies of the federal government.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21063, Public Resources Code.
Discussion: This definition is necessary in order to show that the scope of the term "public agency" under CEQA does not include agencies of the federal government.

15380. Endangered, Rare or Threatened Species

(a) "Species" as used in this section means a species or subspecies of animal or plant or a variety of plant.

(b) A species of animal or plant is:

(1) "Endangered" when its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, disease, or other factors; or

(2) "Rare" when either:

(A) Although not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens; or

(B) The species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered "threatened" as that term is used in the Federal Endangered Species Act.

(c) A species of animal or plant shall be presumed to be endangered, rare or threatened, as it is listed in:

(1) Sections 670.2 or 670.5, Title 14, California Code of Regulations; or

(2) Title 50, Code of Federal Regulations Section 17.11 or 17.12 pursuant to the Federal Endangered Species Act as rare, threatened, or endangered.

(d) A species not included in any listing identified in subsection (c) shall nevertheless be considered to be endangered, rare or threatened, if the species can be shown to meet the criteria in subsection (b).

(e) This definition shall not include any species of the Class Insecta which is a pest to plants or animals whose protection under the provisions of CEQA would present an overwhelming and overriding risk to man as determined by:

(1) The Director of Food and Agriculture with regard to economic pests; or

(2) The Director of Health Services with regard to health risks.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21001 (c), Public Resources Code.

Discussion: This definition is modeled after the definition in the Federal Rare and Endangered Species Act and the sections of the California Fish and Game Code dealing with rare or endangered plants or animals.

The definition provides that plants or animals already listed by a governmental agency as being rare or endangered shall be presumed rare or endangered for the purposes of CEQA. This presumption allows a Lead Agency to consider a listed species as rare or endangered without the need for any further proof. The section also provides that a plant or animal may be treated as rare or endangered even if it has not been placed on an official list. The section also adds the concept that rare or endangered status shall not be applied to insect pests designated by the Director of Food and Agriculture as meeting the criteria in this section.
15381. Responsible Agency

"Responsible Agency" means a public agency which proposes to carry out or approve a project, for which a Lead Agency is preparing or has prepared an EIR or Negative Declaration. For the purposes of CEQA, the term "Responsible Agency" includes all public agencies other than the Lead Agency which have discretionary approval power over the project.


Discussion: This section provides explanation of the term "Responsible Agency".

15382. Significant Effect on the Environment

"Significant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment. A social or economic change related to a physical change may be considered in determining whether the physical change is significant.


Discussion: The first sentence combines the statutory language in the definitions of "significant effect" and "environment" in the interest of clarity because they are interrelated.

The second and third sentences pose a problem of interpretation that has caused controversy for many years. The controversy centers around the extent to which CEQA applies to economic and social effects of projects. In determining whether an effect is significant, however, Section 21083(c) of CEQA requires an effect to be found significant if the activity would cause an adverse effect on people.

This section also codifies the holding in Hecton v. People of the State of California, 58 Cal. App. 3d 653, which ruled that a claim that a project would cause a decline in property values was not enough by itself to require an EIR to be prepared.

In Cathay Mortuary, Inc. v. San Francisco Planning Commission (1989) 207 Cal. App. 3d 275, the court in analyzing significant effect offered inverse guidance regarding whether an alternative site for a proposed park would have better access to sunlight, i.e., it is irrelevant whether some body of opinion views some other alternative site as "better suited" (essentially as a planning determination), if the net impact of the project site is not an adverse change, no EIR is required. In this case, demolition of a building would provide access to sunlight in a portion of the impacted area that currently did not have access to sunlight — in other words, access to sunlight when none currently exists is not an adverse change.

15383. State Agency

"State agency" means a governmental agency in the executive branch of the State Government or an entity which operates under the direction and control of an agency in the executive branch of State Government and is funded primarily by the State Treasury.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Section 21100, Public Resources Code.

Discussion: This section distinguishes state agencies from local agencies. Different requirements may
apply depending on whether a state or local agency is involved. For example, if a project will require a permit from a state agency, the EIR or Negative Declaration on the project must be sent to the State Clearinghouse for review. This term is not defined in the Public Resources Code, and there is often confusion as to whether a particular agency with limited geographical jurisdiction is a state agency or a local agency. For example, the San Francisco Bay Conservation and Development Commission is a state agency, but the Bay Area Air Quality Management District is a local agency for all but Section 21080.5 of CEQA. The definition is an effort to provide a clearer basis for the distinction.

15384. Substantial Evidence

(a) "Substantial evidence" as used in these guidelines means enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached. Whether a fair argument can be made that the project may have a significant effect on the environment is to be determined by examining the whole record before the lead agency. Argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly erroneous or inaccurate, or evidence of social or economic impacts which do not contribute to or are not caused by physical impacts on the environment does not constitute substantial evidence.

(b) Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.


Discussion: "Substantial evidence" as used in the Guidelines is the same as the standard of review used by courts in reviewing agency decisions. Some cases suggest that a higher standard, the so called "fair argument standard" applies when a court is reviewing an agency's decision whether or not to prepare an EIR.

Public Resources Code section 21082.2 was amended in 1993 (Chapter 1131) to provide that substantial evidence shall include "facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts." The statute further provides that "argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence."

15385. Tiering

"Tiering" refers to the coverage of general matters in broader EIRs (such as on general plans or policy statements) with subsequent narrower EIRs or ultimately site-specific EIRs incorporating by reference the general discussions and concentrating solely on the issues specific to the EIR subsequently prepared. Tiering is appropriate when the sequence of EIRs is:

(a) From a general plan, policy, or program EIR to a program, plan, or policy EIR of lesser scope, or to a site-specific EIR;

(b) From an EIR on a specific action at an early stage to a subsequent EIR or a supplement to an EIR at a later stage. Tiering in such cases is appropriate when it helps the Lead Agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21003, 21061, and 21100, Public Resources Code.

Discussion: This definition of "tiering" is modeled closely after the definition in the federal NEPA.
regulations. Tiering is needed in order to provide increased efficiency in the CEQA process. It allows agencies to deal with broad environmental issues in EIRs at planning stages and then to provide more detailed examination of specific effects in EIRs on later development projects that are consistent with or implement the plans. These later EIRs are excused by the tiering concept from repeating the analysis of the broad environmental issues examined in the general plan EIRs.

15386. Trustee Agency

"Trustee Agency" means a state agency having jurisdiction by law over natural resources affected by a project which are held in trust for the people of the State of California. Trustee Agencies include:

(a) The California Department of Fish and Game with regard to the fish and wildlife of the state, to designated rare or endangered native plants, and to game refuges, ecological reserves, and other areas administered by the department;

(b) The State Lands Commission with regard to state owned "sovereign" lands such as the beds of navigable waters and state school lands;

(c) The State Department of Parks and Recreation with regard to units of the State Park System;

(d) The University of California with regard to sites within the Natural Land and Water Reserves System.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.3 and 21080.4, Public Resources Code.

Discussion: This section is included to provide a commonly used and clearly recognizable term to use in place of the statutory phrase describing state agencies "having jurisdiction by law over natural resources affected by the project which are held in trust for the people of the State of California." The section also identifies the four agencies which have been found to meet the statutory formula.

Agencies are designated as Trustee Agencies where they administer lands to protect the natural resources on those lands or where a law gives the agency responsibility for protecting the state's interest in a natural resource as with the Department of Fish and Game's responsibility for fish and wildlife. The Department of Fish and Game is listed as a Trustee Agency for designated rare and endangered native plants because Fish and Game Code Section 1913(c) gives the department special responsibilities for protecting these plants after they have been designated rare or endangered by the Fish and Game Commission

15387. Urbanized Area

"Urbanized area" means a central city or a group of contiguous cities with a population of 50,000 or more, together with adjacent densely populated areas having a population density of at least 1,000 persons per square mile. A Lead Agency shall determine whether a particular area meets the criteria in this section either by examining the area or by referring to a map prepared by the U.S. Bureau of the Census which designates the area as urbanized. Maps of the designated urbanized areas can be found in the California EIR Monitor of February 7, 1979. The maps are also for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The maps are sold in sets only as Stock Number 0301-3466. Use of the term "urbanized area" in Section 15182 is limited to areas mapped and designated as urbanized by the U.S. Bureau of the Census.

Note: Authority cited: Sections 21083 and 21087, Public Resources Code; Reference: Sections 21080.7 and 21083, and 21084, Public Resources Code.

Discussion: This section is included to provide certainty and precision for the portions of CEQA that allow special treatment of projects in urbanized areas. These special provisions apply to residential projects in urbanized areas as well as categorical exemptions for certain kinds of activities. The revisions in this section allows a Lead Agency to determine on its own whether a project is located in
an area meeting the criteria for being "urbanized" even if the area is not included on the Census Bureau maps. This change allows the special relaxations of the CEQA process to be applied in areas.
Amend subsection (i) of Section 15064 of Title 14 of the California Code of Regulations to read:

(i) If an air emission or water discharge meets the existing standard for a particular pollutant, the Lead Agency may presume that the emission or discharge of the pollutant will not be a significant effect on the environment. If other information is presented suggesting that the emission or discharge may cause a significant effect, the Lead Agency shall evaluate the effect and decide whether it may be significant.

(1)(A) Except as otherwise required by Section 15065, a change in the environment is not a significant effect if the change complies with a standard that meets the definition in subsection (i) (3).

(B) If there is a conflict between standards, the lead agency shall determine which standard is appropriate for purposes of this subsection based upon substantial evidence in light of the whole record.

(C) Notwithstanding subsection (i)(1)(A), if the lead agency determines on the basis of substantial evidence in light of the whole record that a standard is inappropriate to determine the significance of an effect for a particular project, the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(2) In the absence of a standard that satisfies subsection (i)(1)(A), the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(3) For the purposes of this subsection a "standard" means a standard of general application that is all of the following:
(A) a quantitative, qualitative or performance requirement found in a statute, ordinance, resolution, rule, regulation, order, or other standard of general application;

(B) adopted for the purpose of environmental protection;

(C) adopted by a public agency through a public review process to implement, interpret, or make specific the law enforced or administered by the public agency;

(D) one that governs the same environmental effect which the change in the environment is impacting; and,

(E) one that governs within the jurisdiction where the project is located.

(4) This definition includes thresholds of significance adopted by lead agencies which meet the requirements of this subsection.

Amend subsection (i) of Section 15064 of Title 14 of the California Code of Regulations to read:

(i) If an air emission or water discharge meets the existing standard for a particular pollutant, the Lead Agency may presume that the emission or discharge of the pollutant will not be a significant effect on the environment. If other information is presented suggesting that the emission or discharge may cause a significant effect, the Lead Agency shall evaluate the effect and decide whether it may be significant.

(1)(A) Except as otherwise required by Section 15065, a change in the environment is not a significant effect if the change complies with a standard that meets the definition in subsection (i)(3).

(B) If there is a conflict between standards, the lead agency shall determine which standard is appropriate for purposes of this subsection based upon substantial evidence in light of the whole record.

(C) Notwithstanding subsection (i)(1)(A), if the lead agency determines on the basis of substantial evidence in light of the whole record that a standard is inappropriate to determine the significance of an effect for a particular project, the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(2) In the absence of a standard that satisfies subsection (i)(1)(A), the lead agency shall determine whether the effect may be significant as otherwise required by this section, Section 15065, and the Guidelines.

(3) For the purposes of this subsection a "standard" means a standard of general application that is all of the following:
(A) a quantitative, qualitative or performance requirement found in a statute, ordinance, resolution, rule, regulation, order, or other standard of general application;

(B) adopted for the purpose of environmental protection;

(C) adopted by a public agency through a public review process to implement, interpret, or make specific the law enforced or administered by the public agency;

(D) one that governs the same environmental effect which the change in the environment is impacting; and,

(E) one that governs within the jurisdiction where the project is located.

(4) This definition includes thresholds of significance adopted by lead agencies which meet the requirements of this subsection.

September 10, 2001

Bill Zumwalt, Director
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Re: Comments on Draft Program Environmental Impact Report for the Draft Dairy Element of the Kings County General Plan

The Center on Race, Poverty & the Environment submits these comments on the Draft Program Environmental Impact Report ("PEIR") for the Draft Dairy Element ("Element") on behalf of the Association of Irritated Resident, an unincorporated association of Central Valley residents dedicated to improving air quality and environmental health in the San Joaquin Valley. The comments demonstrate that the PEIR violates the California Environmental Quality Act (CEQA), Cal. Pub. Res. Code § 21000 et. seq.

The purpose of Environmental Impact Reports, to meet the objectives of CEQA, is "to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided." Cal. Pub. Res. Code § 21002.1(a). The PEIR for the Element fails to meet the Legislature's command in nearly every respect.

CRPE sets forth the following comments specific to the relevant sections of the PEIR. Because the PEIR fails to comply with CEQA, it should be rewritten and recirculated for additional public comment. CEQA requires recirculation when "significant new information is added to an EIR." Cal. Pub. Res. Code § 21092.1. Significant new information changes the EIR in such "a way that deprives the public of a meaningful opportunity to comment upon a substantial adverse environmental effect of the project or a feasible way to mitigate or avoid such an effect." Laurel Heights Improvement Association v. Regents of the University of California (1993) 6 Cal.4th 1112, 1129-1130 (hereafter Laurel Heights II).

I. General Comments on the PEIR

Nature and Background of the Project and Purpose

The PEIR makes clear that the purpose of the Dairy Element and the PEIR is to streamline the dairy permitting process and eliminate future environmental review. Program EIRs can serve two possible functions: (1) as a "first tier" EIR, off which subsequent site specific EIRs and Negative Declarations will branch, or (2) as a single environmental document under which an agency can carry out an entire program without preparing a subsequent environmental document.¹

The PEIR makes it clear that Kings County hopes this Program EIR will serve the later function as a single environmental document thereby foreclosing any opportunity for public comment in the future. However, under CEQA Guidelines § 15168, if a Program EIR is to eliminate the need for future environmental review, it must deal with the effects of the program as specifically and comprehensively as possible. Because CEQA is primarily concerned with providing the public with information and an opportunity to comment on proposed projects, courts look very carefully and demand a very detailed analysis of the specific consequence of a project when the lead agency seeks to do away with future public review.² The subsequent sections of these comments indicate that the PEIR lacks this comprehensive and specific analysis as required by CEQA.

In addition, given the nature of the dairy industry it is uncertain whether a Program EIR


²Id. at 530
for the dairy industry will ever be specific and comprehensive enough to satisfy CEQA. The PEIR recognizes the importance of dairy management practices in preventing environmental impacts from dairies. Underscoring this importance are the number of site specific reports that dairy proponents need to prepare. These include: a geotechnical report, comprehensive nutrient management plan, comprehensive dairy process water disposal plan, hazardous waste material plan, manure treatment management plan, odor management plan, livestock management plan, irrigation management plan, integrated pest management plan, dead animal management plan, wildlife survey, and a fugitive dust emissions control plan. These plans allow analysis of impacts and mitigation to be deferred until after the plans are prepared and thus eliminate any public review of these impacts. Given the importance of site specific information in the process and the importance of public comment on the sheer number of reports, a PEIR that forecloses all future CEQA review for dairies is inappropriate.

Manure Transport

The PEIR does not identify, analyze, or mitigate the environmental impact of transporting manure from dairies in the Dairy Development Overlay Zone (DDOZ) to cropland in the Nutrient Spreading Overlay Zone. See Figure 3-2 at PEIR 3-7. The theoretical maximum herd size depends on dairies in the DDOZ applying manure in the NSOZ. How that manure gets from the dairies to the distant fields has not been identified, analyzed, or mitigated. Decision makers and the public need to be aware of difficult problems so that environmental impacts are not swept under the rug.

BACM Undefined

The Element excludes a definition of the term "Best Available Control Measures" ("BACM") from appendix B of the Element. The Element uses BACM when discussing air quality impacts.

Enforcement

Vigorous enforcement ultimately is what really counts here. The Element will only work if used in conjunction with vigorous enforcement. The Kings County Planning Agency ("Planning Agency") needs to have the financial resources and political will to enforce the Element. Thus far, the Planning Agency has shown a reluctance to enforce violations of conditional use permits.

For example, the Galhandro Dairy exceeded the total number of cows allowed in its CUP and over-applied manure to cropland. The Planning Agency knew of this condition for two years and failed to do anything. The ultimate solution to the problem was to help the dairyman get a
new permit and come into compliance. The County did not penalize, fine, or in any way reprimand the dairyman.

This “enforcement” saga speaks volumes about Kings County’s willingness to enforce the law. The County has shown little or no interest in enforcing existing County law, and there is no evidence in the record which shows an increased commitment to enforce the law. Given the lack of vigorous enforcement history, the policies on which the PEIR relies to prevent or reduce environmental impacts have no practical value whatsoever.

This is especially troubling given that the County hopes to bring existing dairies into voluntary compliance by 2006. The County has eliminated all language that described the consequences of existing dairies failing to come into compliance. In the December 2000 draft of the PEIR, DE 8.1c read “[a]ny dairy that is improperly located or has other specific characteristics that cannot be mitigated to current standards may become a nuisance and may, on those grounds, be required to take specific corrective action such as reducing its herd size, increase usable farmland, ceasing operation, etc.” The fact that this language was stricken from the current draft does not speak well of the County’s willingness to enforce the provisions of this PEIR on dairies in the County.

Buffer Zones

Policies 1.2g, 1.2h and 1.2i create buffer zones around schools, other dairies and residential areas, respectively. Yet, the policies do not limit the distance from dairies to other agricultural uses. Tulare County, in creating its policies, recognized that dairies in close proximity to other agricultural uses can have a negative impact. Kings County’s policies should include an appropriate buffer zone for these other agricultural uses.

II. Theoretical Maximum Herd Size

The PEIR bases numerous calculations and assumptions upon the theoretical maximum herd size for the county. Future dairy development under the Element will consider this herd size. Because the maximum herd size plays such an important role throughout the PEIR and the future planning of the Kings County dairy industry, it is imperative that the herd size estimation is accurately and truthfully calculated. Yet, the analysis does not use the dairy herd figures for

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3Letter from James Rader, Code Compliance Specialist, to Mr. and Mrs. Manuel Galhandro regarding Notice of Violation (March 23, 1998); Letter from Kings County Code Compliance to Mr. and Mrs. Manuel Galhandro regarding Notice of Violation – Final Warning (March 10, 1999); Letter from Lonnie Wass, Senior Engineer, Central Valley Regional Water Quality Control Board to Mr. Manuel Galhandro regarding Notice of Violation (March 24, 2000); Letter from James Rader, Code Compliance Specialist, to Manuel Galhandro regarding Notice of Violation and Order to Comply (April 10, 2000); Estimated Timeline for Conditional Use Permit No. 98-14 (Galhandro). Attached as Appendix A.
the year 2000. The note on DE-7 indicates that the figures were released in April 2001. The PEIR was circulated in May of 2001. The more current figures could have been used, but were not. The PEIR should be recirculated using the current information. Even using the outdated data, the comments in this section show the flaws in the herd size calculation. Because the public and decision makers need an accurate and truthful analysis of Kings County's dairy capacity before an ecological point of no return, the EIR should be recirculated. As an informational document, the PEIR bases environmental impacts of future development upon a flawed maximum herd size.

Cotton and Salt Uptake

The theoretical maximum herd size is based upon two limiting factors: salt and nitrogen. Dairy manure contains 927 pounds of non-nitrogen salts per 100 pounds of nitrogen.\(^4\) If plants do not remove an adequate amount of salt from the soil, salt loading occurs, causing a major threat to groundwater quality.\(^5\)

Cotton accounts for approximately 333,464,000 pounds of theoretical salt uptake per year (166,732 acres of cotton for manure disposal multiplied by the Tulare Lake Basin Plan single crop salt load maximum of 2,000 pounds acre/year). Element Table No. 5. The total salt uptake per year as set forth in Table 5 is 571,321,170 pounds. Cotton acreage therefore accounts for 58.4% of the total salt uptake.

However, the PEIR needs to analyze the cotton salt uptake in order to generate an accurate dairy herd size maximum. Cotton growers harvest the cotton fiber from the plants and till the plants back into the soil. The net amount of salt removed from the soil would only be the salt contained in the harvested cotton itself. Salt remaining in plant tissue would never leave the field. Thus, salt loading would occur in cotton fields creating a substantial threat to groundwater quality.

Nitrogen Calculation

Additionally, crops' nitrogen uptake rates limit the dairy maximum herd size. The calculation of available nitrogen assumes all liquid manure remains stored in lagoons for more

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\(^4\)Regional Water Quality Control Board Santa Ana Region, *Dairies and their Relationship to Water Quality Problems in the Chino Basin, California* (July 1990), at III-21 (hereafter "Chino Basin Study"). Attached as Appendix B; Borba Farms EIR at 4.3-9. Attached as Appendix C. "Non-nitrogen Salts" refers to Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Sulfate (SO\(_4^2\)), and Phosphate (HPO\(_4^3\)).

\(^5\)PEIR 4.3-9 through 4.3-10; See also Chino Basin Study at I-24, I-26 (Chino dairies are responsible for either 88% or 60% of total agricultural salt loading in the Chino Groundwater Basin, depending on methodology employed).
than 60 days, thus leaving 50% of the total excreted nitrogen available for application to crops based on the assumptions laid out in the Element. Element, Table No. 5. Because nitrogen limits the maximum herd size, minimizing the amount of available nitrogen allows for more animals in the herd. The PEIR has set forth no justification for choosing between the 30% (<30 days storage), the 40% (30-60 days) and the 50% the (> 60 days) loss rates. Also, there is no justification for eliminating the 30% (<30 days storage), the 40% (30-60 day storage) and the 50% (> 60 days storage) loss rates.

Salt Uptake

The theoretical maximum herd size depends on the ability of crops to uptake salt. The herd size calculation uses the Tulare Lake Basin Plan’s maximum salt loading figures of 2,000 pounds/acre/year (single-crop) and 3,000 pounds/acre/year (double-crop) to analyze salt loading. However, neither the Element nor the PEIR discloses the actual rates of salt uptake for various crops. Because some crops may uptake less than the Tulare Lake Basin Plan’s figures, some salt loading may occur. Parts of Kings County already have severe levels of salt in the soil and groundwater. See PEIR Figure 4.3-4 at 4.3-10. The PEIR should analyze the anticipated amount of salt loading, including non-nitrate salts, from crop application. This information is critical to decision makers’ ability to weigh the importance of protecting groundwater quality versus dairy development. The Natural Resource Conservation Service Agricultural Waste Management Field Handbook provides calculations necessary to estimate salt uptake. Because this information has been excluded, the PEIR should be recirculated.

Crop Nutrient Utilization

The PEIR does not account for crop uptake of phosphates (P₂O₅) and potash (K₂O). The Natural Resource Conservation Service (NRCS) regards phosphorus (P) as a potential source of surface and groundwater pollution.

“If manure application based on [nitrogen] has occurred for many years, rapid build up of [phosphorous] levels in soils create the potential for [phosphorous] losses to surface waters through runoff. Although protecting groundwater from nitrate leaching and limiting ammonia volatilization are major concerns, the management emphasis has shifted to [phosphorous] in many areas of the U.S.”

The PEIR should evaluate phosphorous impacts to surface and groundwater. These

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6Natural Resource Conservation Service, U.S. Dept. of Agriculture, Agricultural Waste Management Field Handbook at 6-19 to 6-21 (hereafter “Field Handbook”). Attached as Appendix D.

impacts will occur given the Element's decision to base nutrient loading on nitrogen. This is a major potential environmental impact that the PEIR failed to identify, analyze or mitigate. The PEIR should be recirculated.

The PEIR concludes that there will be a less than significant impact to groundwater under the Element. The Element establishes a maximum herd size for the County. The maximum herd size is based on nitrogen and salt limiting factors. The Element analyzes nitrogen through crop uptake (demand) and cow output (supply). The more demand for nitrogen, the more cows the County can have.

Nitrogen uptake figures, as expressed in pounds/acre/year, are set forth at Table 5 of the Element. The table claims that the nitrogen uptake figures are based on the U.C. Extension Service and the NRCS. The table claims a certain amount of nitrogen demand given a certain yield per crop. This table overstates the demand for nitrogen and, as a result, allows more cows in the maximum theoretical herd size.

CRPE calculated the nitrogen uptake of alfalfa and cotton using the methodology set forth in the NRCS Agricultural Waste Management Field Handbook. The results are set forth in the table below:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Plant N Percentage</th>
<th>Yield (lb/acre/year)</th>
<th>N Uptake (lb/acre/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>2.25%</td>
<td>18,000(^{10})</td>
<td>405</td>
</tr>
<tr>
<td>Cotton (lint)</td>
<td>2.67%</td>
<td>1,500(^{12})</td>
<td>40</td>
</tr>
</tbody>
</table>

Using NRCS percentages to calculate nitrogen uptake illustrates the fact that despite citation to the NRCS in general, the uptake figures used in Table 5 of the Element overstate the

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\(^{8}\) Alfalfa and cotton account for 226,219 acres of the 360,024 available crop acres as used in Table 5 (62.8%).

\(^{9}\) Field Handbook at 6-19 to 6-21.

\(^{10}\) Element at Table No. 5.

\(^{11}\) Only cotton lint is set forth because cotton growers plow the plant stalk back into the ground after harvest. Nutrients in the plant therefore to not leave the field.

\(^{12}\) Merced County Comprehensive Nutrient Management Plan at Table 6. CRPE used this figure because it could not ascertain the weight of bales as used in the Table 5. Attached as Appendix E.
demand of Nitrogen and thus allow a larger maximum herd.

If this maximum herd number is used for analysis in the PEIR, then conclusions in the PEIR regarding threats to groundwater are not accurately based upon fact. It would be an abuse of discretion to rely on the data in Table 5, citing to the NRCS, when actual analysis under the NRCS Field Handbook yields a major decrease in the nitrogen uptake figures.

**III. Air Quality**

**Setting**

The PEIR discloses the fact that the San Joaquin Valley Air Basin is currently in nonattainment for the Federal standards for ozone and particulate matter with an aerodynamic diameter less than or equal to ten microns (PM₁₀). PEIR 4.2-3 The PEIR does not disclose the degree of nonattainment (i.e. “severe” or “serious”), nor does the PEIR disclose ambient levels of criteria air pollutants or ammonium nitrate.

Moreover, the PEIR does not disclose the consequences to Kings County, the other counties in the Air Basin, and California if the San Joaquin Valley Air Basin does not achieve attainment under the Federal Clean Air Act. The PEIR should disclose the consequences of continued nonattainment to highway funds, businesses, and local governments through increased regulatory requirements and loss of Federal funds.

**Health and Environmental Effects of Air Pollution**

CEQA requires that the EIR identify and discuss the direct and indirect significant effects of a project with consideration to short-term and long-term effects. CEQA Guidelines § 15216.2(a). The PEIR estimates and describes thousands of tons of air pollutants that will be emitted under the terms of the Element. The PEIR devotes a few sentences to the discussion the health and environmental effects associated with the project’s huge emissions. Nor does the PEIR attempt to describe the economic consequences of air quality impacts. While the PEIR talks about air pollution, it does not inform decision makers or the public what this air pollution means.

The PEIR fails to analyze ozone health impacts

The PEIR inadequately examines ozone’s effect on human health. ROG reacts with oxides of nitrogen to form ozone, also known as smog. The PEIR quantifies the amount of ROG generated from dairies, but does not disclose the amount of ozone generated. Furthermore, the PEIR does not discuss the health effects from ozone adequately. In one sentence, the PEIR discloses that ozone exposure “causes damage to lung tissue in humans.” PEIR at 4.2-14. Ozone
is among the most dangerous of the common air pollutants. The PEIR must analyze impacts associated with this project and future dairy projects permitted pursuant to this PEIR. Ignoring impacts violates CEQA. A "legally adequate EIR must contain sufficient detail to help ensure the integrity of the process of decisionmaking by precluding stubborn problems or serious criticism from being swept under the rug." Kings County Farm Bureau v. 221 Cal.App.3d 692, 733; see also Laurel Heights Improvement Association v. Regents of the University of California (1988) 47 Cal.3d 376, 405-405 ("[a]n EIR must include detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project").

Given the Air Basin's nonattainment status and the severity of the ozone pollution in Kings County and the San Joaquin Valley, a one sentence acknowledgment of health effects is insufficient under CEQA. Decision makers and the public need to be able to put the project in a context so that they may critically evaluate the benefits and burdens of further dairy development. An analysis of ROG emissions must do more than just quantify those emissions. It must inform decisionmakers and the public about what that pollution means.

Moreover, the PEIR fails to disclose the quantities of ammonium nitrate and hydrogen sulfide emissions. The County is required to make a reasonable effort to discover and disclose impacts in this environmental document. By sweeping this issue under the rug, the PEIR has precluded meaningful public participation by denying the public information about ammonia (ammonium nitrate) and hydrogen sulfide effects. The PEIR thus fails in its core function as an informational document.

The PEIR fails to meaningfully disclose documented particulate matter health effects

The PEIR fails to identify health impacts associated with particulate matter pollution. Ammonia reacts with oxides of nitrogen to form ammonium nitrate, a PM$_{10}$ particulate. The setting section identifies PM$_{10}$ and PM$_{2.5}$ yet explains their health effects in one sentence. See PEIR at 4:2-11, 12. The PEIR discloses that PM$_{10}$ aggravates respiratory conditions such as asthma and PM$_{2.5}$ has been linked to "asthma, bronchitis, acute and chronic respiratory systems... and premature death." PEIR 4:2-13. Given the severity of the potential health effects, this is analysis is woefully inadequate.

The PEIR’s failure to discuss health impacts associated with particulate matter pollution precludes meaningful public participation: when the PEIR limits disclosure, the public is denied a meaningful opportunity to comment upon the project’s other health impacts – increased risk of death, for example. The DEIR should be recirculated with information detailing particulate matter health impacts.

While the PEIR discloses that PM$_{2.5}$ causes premature death, it does not explain what that

\footnote{American Lung Association, \textit{State of the Air}: 2002 at 21. Attached as Appendix F.}
means and how many people and expect to be affected nor does it discuss the similar health related effects of PM$_{10}$. PEIR 4:2-11,12. A recent study published in the NEW ENGLAND JOURNAL OF MEDICINE concluded that levels of particulate matter with an aerodynamic diameter of ten microns or less (PM$_{10}$) are directly related to death rates overall, and to cardiovascular and respiratory death rates in particular.$^{14}$ The study found that with each increase of 10 $\mu$g per cubic meter of PM$_{10}$, the relative rate of death from all causes rises by .51%.$^{15}$ The study further found that with each increase of 10 $\mu$g per cubic meter of PM$_{10}$, the relative rate of death from cardiovascular and respiratory causes rises by .68%.$^{16}$ The study concludes by stating that the "analyses provide evidence that particulate air pollution continues to have an adverse effect on the public's health and strengthen the rationale for limiting levels of respirable particles in outdoor air."$^{17}$

Particulate matter pollution, especially fine particulate matter (PM$_{2.5}$), has a major health impact.$^{18}$ Those most at risk are the very young, the elderly, and those with pre-existing cardiopulmonary illness. Particulate pollution's long term health consequences on otherwise healthy adults shortens life expectancy by 2.5 to 3.1 years.$^{19}$ The PEIR needs to discuss the health related effects of particulate matter pollution. Its failure to do so precludes informed decisionmaking and public participation: decisionmakers and the public have no idea what health impacts this project will have both currently and in the future as more dairies are built in Kings County pursuant to the PEIR.

**Piecemealing**

The PEIR must view the project as a whole, analyze, and mitigate impacts. CEQA prohibits "piecemealing" of the project. *See CEQA Guidelines § 15165.* "[E]nvironmental considerations do not become submerged by chopping a large project into many little ones, each


$^{15}$Id. at 1744.

$^{16}$Id. at 1745.

$^{17}$Id. at 1748.


with a potential impact on the environment, which cumulatively may have disastrous consequences.” Burbank-Glendale-Pasadena Airport Authority v. Henster (2d Dist. 1991) 233 Cal.App.3d 577, 592 (hereafter “Henster”).

The PEIR, in effect, piecemeals project-related PM_{10} emissions. Specifically, the project would generate PM_{10} from construction-related emissions (Impact 4.2-1), construction equipment emissions (Impact 4.2-2), operational fugitive dust (Impact 4.2-3), operational dairy equipment exhaust emissions (4.2-4), and associated operational vehicular exhaust emissions (Impact 4.2-10).

The PEIR also piecemeals project-related ROG emissions. Implementation of the Element would generate ROG from construction equipment emissions (Impact 4.2-2), operational dairy equipment exhaust emissions (4.2-4), manure decomposition (Impact 4.2-6), and associated operational vehicular exhaust emissions (Impact 4.2-10).

Implementation of the Element would result in massive PM_{10} and ROG emissions from the combined sources identified above, yet the PEIR chops up the sources of emissions into innocuous less-than-significant chunks. This practice offends the letter and spirit of CEQA. A new PEIR should be drafted which considers and mitigates the impact of the Element as a whole, rather than individual parts.

Impact 4.2-1: Construction-Related PM_{10} Emissions

The PEIR does not quantify construction-related PM_{10} emissions. Further, the PEIR claims that with control measures specified by Element Policy 5.1d, the impact will be reduced to a less-than-significant level. PEIR at 4.2-52. The PEIR reaches this conclusion without data and without analysis. The PEIR sets forth no baseline emission figure nor a discussion of the reduction measures contained in Policy 5.1d would have. This constitutes a prejudicial abuse of discretion.

A potential mitigation measure for construction-related PM_{10} emissions would be a requirement to purchase PM_{10} offsets. The proponent would “offset” PM_{10} emissions from the project using emission reductions from other nearby sources. Alternatively, the reductions could from within the project itself. The PEIR, as discussed above, identifies several pollutants from various activities on the dairy. By controlling emissions in one area to offset emission in another, the project could also move forward and reduce the air pollution impacts overall. The project and the non-project reductions would allow the project to go forward and reduce the overall air quality burden.\(^{29}\)

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\(^{29}\) Letter from Cliff R. Scholle, Air Quality Scientist, to Tony Olivera, Vice-Chair, Kings County Board of Supervisors regarding the Chamberlain Ranch Project at 2 (March 24, 2000). (hereafter “Scholle Letter”). Attached as Appendix J.
Impact 4.2-2: Construction-Related Vehicular Exhaust Emissions

The PEIR does not quantify construction-related vehicular ROG, NOx, and PM\textsubscript{10} emissions. Further, the PEIR claims that with control measures specified by Element Policy 5.1g, the impact will be reduced to a less-than-significant level. PEIR at 4.2-53. The PEIR reaches this conclusion without data and without analysis. The PEIR sets forth no baseline emission figure nor a discussion of the reduction measures contained in Policy 5.1g would have. This constitutes a prejudicial abuse of discretion.

Using data from the Boswell EIR, CRPE calculated construction-related exhaust emissions from new dairy construction. The Four-dairy Chamberlain Ranch Project (Boswell) would have generated 2,076 pounds of ROG, 31,816 pounds of NOx, and 2,808 pounds of PM\textsubscript{10} during construction. Kings County’s remaining dairy capacity equals 542,928 cows (PEIR 6-6, Table 6-1).\textsuperscript{21} Therefore, future dairy expansion equals 11.38 Chamberlain Ranch-sized projects (542,928 divided by 47,700\textsuperscript{23}). Using these numbers, construction-related exhaust emissions under the terms of the Element would be 11.81 tons of ROG, 181 tons of NOx, and 15.97 tons of PM\textsubscript{10}.

These emissions exceed mandatory significance thresholds for ROG, NOx, and PM\textsubscript{10}. PEIR Table 4.2-4 at 4.2-44 (10, 10, and 15 tons, respectively). The PEIR illegally piecemeals the Element by separately analyzing and mitigating air emissions impacts for ROG, NOx, and PM\textsubscript{10} from different components of the element. Because the project as implemented would lead to a significant environmental impact from construction-related ROG, NOx, and PM\textsubscript{10} emissions, the PEIR must discuss feasible mitigation measures. See CEQA Guidelines § 15126.4. The PEIR’s less-than-significant finding constitutes a prejudicial abuse of discretion.

A potential mitigation measure would be a requirement that (1) diesel-powered construction equipment use the cleanest burning diesel fuel available; (2) only “clean diesel” equipped construction equipment may be used in the construction and grading of a new or expanded dairy operations; and offsets.

Impact 4.2-3: Operational PM\textsubscript{10} Emissions

The most glaring omission in this discussion of PM\textsubscript{10} emissions is the absence of any discussion of health impacts from PM\textsubscript{10} emissions. Decision makers and the public need to know the impacts associated with dairy operation before those impacts occur. This PEIR should analyze health impacts associated with particulate matter pollution.

The PEIR considers that operational PM\textsubscript{10} emissions alone constitute a significant and

\textsuperscript{21}Boswell EIR at 4.2-28. Attached at Appendix K.

\textsuperscript{23}Boswell EIR at 2-1. Attached at Appendix K.
unavoidable impact. Policy 5.1f recognizes that water or chemical stabilizers will have an
efficacy rate of 50% to 75%. DE-37. The PEIR states that no “additional feasible mitigation
measures are available.” PEIR at 4.2-60. However, the PEIR does not consider Best Available
Control Measures (BACM)23 beyond the most recently adopted San Joaquin Valley Unified Air
Pollution Control District (SJVUAPCD) Regulation VIII. This regulation currently does not
require dust control in corrals, nor does the proposed version of the rule.

A potential mitigation measure would be the requirement of BACM, accompanied by a
definition, for reducing cattle generated corrals PM_{10} emissions. As set forth in the PEIR, there is
no Element Policy or mitigation measure which addresses this huge source of PM_{10} emissions.

A second potential mitigation measure would be a requirement that support stack be put
to pasture, rather than confined in corrals. Milk Cows confined in freestalls generate “little to no
fugitive dust.” PEIR at 4.2-54. Pasture would generate far less PM_{10} emissions than corrals.
The pasture mitigation would also eliminate the water quality impact of corrals, infra, provide
habitat to some species, and may be used to apply manure wastewater.24

An third potential mitigation measure for operational PM_{10} emissions would be the use of
offsets. The proponent would “offset” PM_{10} emissions from the project using emission
reductions from other nearby sources. The non-project reductions would allow the project to go
forward and reduce the overall air quality burden.25

Impact 4.2-4: Operational vehicular emissions

The PEIR does not quantify expected emissions from dairy equipment. The section relies
upon Policy 5.1f to claim that dairy exhaust emissions under the element would be reduced to a
less-than-significant level. The PEIR accomplishes this feat by “piecemaking” the impact of the
Element. CEQA prohibits piecemaking. See CEQA Guidelines § 15165. “[E]nvironmental
considerations do not become submerged by chopping a large project into many little ones, each
with a potential impact on the environment, which cumulatively may have disastrous
consequences.” Hensler 233 Cal.App.3d at 592.

Policy 5.1f allows operational emissions to be piecemade into individual new or
expanded dairy projects implemented under the Element. A 5,000 milk cow dairy facility would
not emit ROG, NOx, and PM_{10} in quantities that would exceed SJVUAPCD significance
thresholds. The PEIR must evaluate the impact of the program as a whole and not piecemade

23The Element does not define BACM. Therefore, the public and decision makers do not
know what the term means or requires.

24Pasture land uptakes 192 lbs/acre/year of nitrogen. See Element, Table No. 5.

25Scholle Letter.
into more manageable chunks.

Implementation of the Element would cause massive amounts of emissions from operational dairy equipment. A 5,000 milk cow dairy facility would emit 0.4, 4.6, and 0.3 tons of ROG, NOx, and PM10 per year, respectively. PEIR at 4.2-60. The Element allows for future growth of 257,312 additional milk cows. PEIR at 2-2. This means that the Element allows approximately fifty-one additional 5,000 milk cow dairy facilities (244,715 divided by 5,000 equals 51.5). Using simple math, the total emissions from operational dairy equipment at new and expanded dairies under the Element would be 20.6, 234.6, and 15.5 tons of ROG, NOx, and PM10 per year, respectively.

These emissions exceed mandatory significance thresholds for PM10, 15 tons per year, ROG and NOx, 10 tons per year each. PEIR Table 4.2-4 at 4.2-44. The PEIR illegally piecemeals the Element by separately analyzing and mitigating air emissions impacts for ROG, NOx, and PM10 from different components of the element. Because the project as implemented would lead to significant environmental impact from dairy equipment ROG and NOx emissions, the PEIR must discuss feasible mitigation measures. See CEQA Guidelines § 15126.4. The PEIR’s less-than-significant finding constitutes a prejudicial abuse of discretion.

A potential mitigation measure would be the requirement that all future new dairies and dairy expansions use natural gas powered vehicles and farm equipment. Dairies can even become their own supplier of fuel, if captured on-site methane is used as fuel.

Impact 4.2-5: Odor

The PEIR recognizes that manure treatment technologies (i.e. aerobic treatment systems or anaerobic digester systems) “are available to reduce odors generated by manure storage and collection systems.” PEIR at 4.2-63. The PEIR relies on a number of Element Policies in its conclusion that the Element when implemented would reduce dairy odor. PEIR at 4.5-64, 65, 66.

Element Policy 5.1c requires the dairy proponent to prepare a manure treatment management plan (MTMP). This plan must include advanced treatment technology to reduce emissions of ROG and other air pollutants. The policy states that advanced treatment technologies include anaerobic digesters, aerobic treatment or a combination of the two. However, the policy does not specify what system is to be used or if these are the only systems that may be used. Rather, the PEIR defers odor mitigation measures to the future discretion of the proponent and the Dairy Monitoring Office based on a determination of what is “economically feasible.” The PEIR may not defer “the obligation to formulate and adopt mitigation until a specific development project is proposed.” See Rio Vista Farm Bureau Center v. County of Solano (1st Dist. 1992) 5 Cal.App.4th 351, 376 (hereafter Rio Vista); Citizens for Quality Growth v. City of Mt. Shasta (3d Dist. 1988) 198 Cal.App.3d 433, 442; see also CEQA

26Remy at 388.
Guidelines § 15126.4(a)(1)(B).

The policy then goes on to require that MTMP demonstrate that the advanced treatment selected must achieve a 50% reduction in volatile solids within the treated manure and wastewater. This policy is based on the assumption that when 100% of the volatile solids are removed from the manure, no additional gaseous compounds are released. PEIR 4:2-21. However, the PEIR provides no support for this assumption. In fact, the PEIR, states that the effectiveness of these manure treatment systems to control air pollution is not known. PEIR 4:2-27. Without supplying the documentation supporting its assumption, the County is preventing the public and decision-makers from fully participating in the process.

Element Policy 6.1c supplements policy 5.1c by requiring the Dairy Monitoring Office to establish monitoring the implementation of the MTMP. Here again, this supposedly comprehensive PEIR defers regulation making and implementation to another agency. This is a violation of CEQA, as stated above. Policy 6.1f sets out some minimum requirements for this monitoring program. Policy 6.1f is nebulous. It states that “[i]n the event testing methods are developed for estimating ROG, NOx, hydrogen sulfide, ammonia, and methane emissions from the treatment process become available...” However, no criteria is established for determining when these methods are “available.” There is always disagreement about the appropriateness of testing methods. How will this be resolved to ensure that monitoring is performed in the County? The public and decision-makers need this information to evaluate the project and participate in the process. Exclusion of this information is a violation of CEQA.

Impact 4.2-6: ROG Emissions

The PEIR fails to adequately discuss and require feasible mitigation measures for ROG emissions. For the reasons set forth for Impact 4.2-5, supra, the PEIR violates CEQA and should be recirculated.

Furthermore, the PEIR’s discussion of ROG emissions lacks sufficient analysis. In order to complete the required analysis, the lead agency is to “attempt in good faith to fulfill its obligation under CEQA to provide sufficient meaningful information regarding the types of activity and environmental effects that are reasonably foreseeable.” Stanislaus Natural Heritage Project v. County of Stanislaus (1996) 48 Cal.App.4th 182, 206. In Stanislaus, the disputed EIR stated that there would be a “significant unavoidable impact,” but did not include the facts describing that impact, citing the lack of studies and lack of determination of the exact source of water for a housing development. The court stated that this kind of conclusory statement with no facts to assist in the decision-making process defeated the purpose of CEQA. Id. at 195.

As in Stanislaus, the PEIR here lacks facts and analysis concerning the impact massive ROG emissions would have on air quality in Kings County and the Valley. The San Joaquin Valley Air Basin is in nonattainment for ozone, yet the PEIR omits discussion on how increased ROG emissions would impact nonattainment status and region-wide efforts to achieve
attainment. The PEIR fails to adequately analyze the impacts from ROG emissions. The PEIR fails to analyze the amount of ozone generated by ROG emissions nor does it analyze impacts to human health or vegetation.27 A glib finding of significant and unavoidable, without facts necessary to an informed decision, precludes informed decision making and public participation.

Impact 4.2-7: Ammonia Emissions

The PEIR quantifies ammonia emissions and discloses that ammonia reacts with sulfates and nitrates in the atmosphere to form ammonium nitrate, a PM_{2.5}. The PEIR does not attempt to quantify the amount of ammonium nitrate which forms in the San Joaquin Valley Air Basin as a result of ammonia emissions from manure decomposition. Because of the severe health issue surrounding PM_{2.5} impacts, the PEIR should identify and analyze PM_{2.5} emissions.

"The EIR has been described as the ‘heart of CEQA’; it is an ‘environmental alarm bell’ which has the objective of alerting the public and governmental officials to the environmental consequences of decisions before they have reached ecological points of no return." Rio Vista 5 Cal.App.4th at 368. The public and the decision makers need to know the implications of ammonia emissions and not just how many tons the cows of Kings County will generate. Fine particulate matter has a tremendous public health impact and this PEIR must analyze the issue. An EIR is an informational document; this PEIR provides no health analysis of ammonia impacts or ammonium nitrate.

Here, Kings County’s PEIR violates CEQA in the same way the EIR did in Stanislaus.28 The PEIR lacks facts concerning the amount of PM_{2.5} generated from Kings County dairies and the impact that pollution will have on Valley residents. Kings County has not fulfilled its obligation under CEQA to provide sufficient, meaningful information on ammonia impacts. A glib finding of significant and unavoidable, without facts necessary to an informed decision, precludes informed decision making and public participation.

The PEIR also fails to adequately discuss and require feasible mitigation measures for ammonia emissions. For the reasons set forth for Impact 4.2-5, supra, the PEIR violates CEQA and should be recirculated.

Impact 4.2-8: Hydrogen Sulfide Emissions

The PEIR also fails to adequately discuss and require feasible mitigation measures for hydrogen sulfide emissions. The PEIR fails to quantify hydrogen sulfide emissions. Additionally, for the reasons set forth for Impact 4.2-5, supra, the PEIR violates CEQA. The PEIR should be recirculated.

27Summary by Jeanne Panek, PhD. Attached as Attachment L.

28See Comments on Impact 4.2-6.
Impact 4.2-9: Methane Emissions

The PEIR also fails to adequately discuss and require feasible mitigation measures for methane emissions. For the reasons set forth for Impact 4.2-5, supra, the PEIR violates CEQA. The PEIR should be recirculated.

Impact 4.2-10: Increased Local Air Pollutant Emissions from Dairy-Related Vehicular Traffic

The PEIR identifies dairy-related vehicular air emissions. It lists the pollutants CO, ROG, NOx, and PM_{10} but does not quantify the emissions. Without analysis, the PEIR concludes that CO, ROG, NOx, and PM_{10} emissions will not exceed SJVUAPCD significance thresholds. Thus, the PEIR violates CEQA because the County has reached a less-than-significant impact conclusion without any analysis or evidence.

The Boswell EIR quantified dairy-related vehicular emissions. CRPE calculated dairy-related vehicular emissions for new or expanded dairies under the Element using the figures contained within the Boswell EIR. Dairy A for the Boswell Dairy Development was planned to contain 7,560 total cows.\textsuperscript{29} Dairy A's dairy-related vehicular emissions were estimated to be 0.19, 0.97, and 0.02 tons per year of ROG, NOx, and PM_{10}, respectively. Kings County's remaining dairy capacity equals 542,928 cows. PEIR at 6-6. Thus, Kings County would develop an additional 71.8 dairies equivalent in size to Dairy A. Using Dairy A's figures, the future development of Kings County's dairy herd under the terms of the Element would generate 13.62, 69.6, and 1.4 tons per year of ROG, NOx, and PM_{10}, respectively.\textsuperscript{30}

These emissions exceed mandatory significance thresholds for ROG and NOx, 10 tons per year each. PEIR Figure 4.3-4, Table 4.2-4 at 4.2-44. The PEIR illegally piecemeals the Element by separately analyzing and mitigating air emissions impacts for ROG, NOx, and PM_{10} from different components of the element. Because the project as implemented would lead to a significant environmental impact from dairy-related vehicular ROG and NOx emissions, the PEIR must discuss feasible mitigation measures. See CEQA Guidelines § 15126.4. The PEIR's less-than-significant finding constitutes a prejudicial abuse of discretion because the County has failed to proceed in a manner required by law.

\textsuperscript{29}Boswell EIR at 3-5. Attached at Appendix K.

\textsuperscript{30}The Boswell EIR did not estimate CO emissions. A recirculated PEIR should quantify CO emissions.
IV. WATER QUALITY

Surface Water Quality

The PEIR does not discuss the current state of Kings County’s surface waters. “The EIR must demonstrate that the significant environmental impacts of the proposed project were adequately investigated and discussed and it must permit the significant effects of the project to be considered in the full environmental context.” CEQA Guidelines, § 15125(c) (emphasis added). Individual and cumulative impacts must be evaluated against an environmental baseline. Kings County has made no effort to disclose the quality of its surface waters. The PEIR should be recirculated with information on surface water quality.

Groundwater Quality

The PEIR recognizes that groundwater quality in Kings County has been impacted. However, the PEIR only establishes the environmental baseline for groundwater quality impacts by referring to a 1995 U.S. Geological Survey report and a Tulare Lake Drainage District Report. PEIR at 4.3-9 through 4.3-12. The greatest dairy threat to water quality is contamination of groundwater. The Element makes policy decisions concerning how much nitrogen and salt loading will be acceptable, yet the PEIR does not even discuss the level of nitrates in Kings County Groundwater. Nor does the PEIR investigate current salt concentrations in the regions groundwater. Instead it relies on third party data generated more than five years ago.

Kings County must make a reasonable effort to find and disclose the current state of groundwater quality before it certifies a PEIR which charts the course of future dairy development. Kings County may not reach conclusions regarding the significance of impacts if it has not established an adequate baseline on which decision makers will weigh environmental impacts. See CEQA Guidelines 15125(c).

Impact 4.3-1: Construction Runoff

The PEIR discusses impacts generally, but does not quantify or analyze the impacts of construction runoff. The PEIR also does not analyze how implementation of existing regulations (e.g. Storm Water Pollution Prevention Plan) would reduce storm water runoff to a less-than-significant level. The PEIR is an informational document, and this section lacks information necessary for the public and decision makers to evaluate impacts.

4.3-4: Flood Impacts

The Element permits manure and wastewater application in flood zones, except during flooding or threat of flooding. The PEIR does not analyze or mitigate impacts to surface water quality when floodwaters inundate fields where manure was applied. The PEIR claims that treatment systems would mitigate any impacts to public water supplies. This mitigation only
protects people from flood related impacts. The PEIR does not identify or discuss feasible mitigation measures to mitigate impacts to ecosystems from manure contaminated flood waters. “A legally adequate EIR must contain sufficient detail to help ensure the integrity of the process of decisionmaking by precluding stubborn problems or serious criticism from being swept under the rug.” Kings County Farm Bureau, 221 Cal.App.3d at 733. This PEIR contains no information whatsoever regarding flood impacts. So long as the Element allows manure disposal in flood zones, it needs to inform decision makers and the public about likely consequences, as in the case of Hurricane Floyd, when floods caused massive discharges from North Carolina hog concentrated animal feeding operations.

Impact 4.3-5: Operational Impact to Surface Waters

A potential mitigation measure for impacts to surface waters would make phosphorous the limiting factor in the comprehensive nutrient management plans (CNMP). The PEIR identifies phosphorous as a threat and states that “the County should be particularly vigilant in controlling discharges of phosphorous to surface waters.” PEIR at 4.3-20. Policy 4.1b does not discuss whether nitrogen or phosphorous will be the limiting factor in the CNMP. The NRCS recommends CNMPs budget for nitrogen, phosphorous, and potassium.31

The PEIR identifies atmospheric fallout of ammonia as an impact to surface water quality, but provides little analysis.32 The PEIR further dispenses with the issue by claiming that the “Air Quality section of the PEIR includes mitigation measures designed to reduce emissions of nitrogen-containing compounds, and these measures would be expected to reduce potential indirect impacts to surface water quality of distant water bodies to a less-than-significant level.” PEIR at 4.3-21. The PEIR failed to adequately handle the impact of air emissions to surface water quality in two ways.

First, the PEIR failed to analyze the impact. It did not establish an environmental baseline of surface water quality and did not quantify or analyze the impact of nitrogen-containing compounds to Kings County surface water quality. The failure to include this relevant information constitutes a prejudicial abuse of discretion. Decision makers and the public lack information necessary to consider the environmental impact to surface waters. “A prejudicial abuse of discretion occurs if the failure to include relevant information precludes informed decisionmaking and informed public participation, thereby thwarting the statutory


32The PEIR did not discuss the existing surface water quality baseline, section IV, supra. Any discussion of impacts must be weighed against a baseline. For example, what is the amount of nitrogen affecting surface water quality and how will the atmospheric fallout of ammonia impact surface water quality? The EIR has not made this analysis and therefore fails its core function as an informational document.
goals of the EIR process." Kings County Farm Bureau, 221 Cal.App.3d at 712. The PEIR should be amended and recirculated so that decision makers and the public have an opportunity to evaluate airborne discharges of pollutants to surface water.

Second, the PEIR dispensed with the problem by claiming that mitigation measures in the Air Quality section would mitigate the problem. The flaws of Impact 4.2-7 are outlined above. The PEIR should be rewritten to provide the missing analysis and recirculated.

Impact 4.3-6: Depletion of Water Resources

The PEIR does not analyze whether a net increase in groundwater overdraft will occur. It evaluates water consumption differences between dairies and irrigated crop land and concludes that dairies save water. However, the PEIR ignores the issue of consumptive water sources and aquifer recharge. The question of dairy-related overdraft as a result of new and expanded dairies went unanswered. Rather, the PEIR and Policy 3.2h defers this analysis until a site specific review can be done at which time mitigation measures will be imposed. DE- 24-25. Thus, the PEIR is inadequate because it failed to analyze overdraft. Kings County may not, and should not, sweep this difficult issue under the rug. See Kings County Farm Bureau, 221 Cal.App.3d at 733.

Impact 4.3-7: Operational Impact to Groundwater

Theoretical Herd Size

Operationally, new and expanded dairies in Kings County will impact groundwater. The Element calls for a certain maximum dairy herd. As these comments point out, supra, the theoretical herd calculation is flawed; a herd size contemplated by the Element would lead to groundwater impacts.

Groundwater Impacts

Existing dairy regulations may not adequately protect groundwater quality. PEIR at 4.3-32. A Central Valley Regional Water Quality Control Board (CVRWQCB) study concludes that even well run dairies contaminate groundwater. From June 1993 to August 1994, the CVRWQCB conducted groundwater testing funded by the Federal Statewide Basin Planning Program. The CVRWQCB sank 44 shallow monitoring wells beneath five Stanislaus and Merced County dairies. Dairies were selected “to determine what usually occurs under typical well run dairies.”33 The size of the dairies monitored by the CVRWQCB ranged from 400-900 milk cows.

The dairies are typical in operation. All employed a closed-loop nutrient management plan, which uses dairy lagoon waste water for the irrigation of feed crops. Some of the dairies supplemented the waste water with commercial fertilizer.\textsuperscript{34}

The national maximum contamination level (MCL), which is the national maximum safe level for drinking water, of nitrate as nitrogen is 10 mg/l. Water samples at the dairies ranged from as low as .02 mg/l of nitrate as nitrogen to as high as 250 mg/l. The average sample contained 49 mg/l.\textsuperscript{35}

- Wells beneath corrals averaged 74 mg/l.
- Wells near waste water containment ponds averaged 45 mg/l.
- Wells beneath fields fertilized with waste water and fertilizer averaged 38 mg/l.
- Wells off-site consistently provided nitrate as nitrogen levels below the MCL.\textsuperscript{36}

The CVRWQCB study also documents severe salinity concentrations beneath the dairies. The federal MCL for TDS is 500 mg/l. Wells beneath fields averaged 925 mg/l. Wells beneath the wastewater lagoons averaged 1294 mg/l and wells beneath corrals averaged 1689 mg/l.

The CVRWQCB study demonstrates that even well-run dairies are capable of causing serious groundwater contamination, besides over-application of manure and wastewater to crops, dairies impact groundwater with discharges from corrals and wastewater lagoons.

**Corrals**

In the CVRWQCB study, the highest levels of nitrate and salt contamination occurred beneath corrals. In a modern, freestall dairy, support stock occupy corrals. A typical 1,000 milk cow dairy will have 1,110 support stock confined exclusively to corrals. Element at DE-9. These support stock defecate and urinate on the ground. Policy 5.1e calls for periodic removal of corral manure. Element at DE-37.

The PEIR claims that the corrals will not “contribute any more nitrates or salts to the subsurface than the adjacent cropland.” PEIR at 4.3-34. The CVRWQCB study directly refutes this contention. Moreover, a Visalia study revealed high concentrations of nitrates below some

\textsuperscript{34}Dairy Groundwater Testing at 2.

\textsuperscript{35}Dairy Groundwater Testing at 3.

\textsuperscript{36}Dairy Groundwater Testing at 4.
dairies, especially beneath the corrals and wastewater lagoons. The PEIR relies primarily on two studies to reach a less-than-significant impact conclusion. Both studies are weak and the County may not rely upon them since they do not support the PEIR’s conclusion.

First, the County claims that trampled manure creates a seal, preventing groundwater contamination. PEIR at 4.3-34. The PEIR further states that removal of the upper most inch of the layer breaks the seal and continued disturbance of the seal “may allow substantial infiltration of nutrients.” PEIR at 4.3-34. The Element calls for periodic removal of this special layer of manure: it requires the corrals to have manure scraped and removed. Element at DE-37. Therefore, the PEIR’s reliance upon the Sweeten study is misplaced: any protective seal will be removed when the corrals are periodically scraped, allowing seepage to groundwater.

Second, the PEIR relies upon a study from 1972 which claims that feedlots on silty loam soil contribute no more pollutants to groundwater than adjacent cropland. PEIR at 4.3-34. This study predates Title 27 regulations which govern dairy application of wastes to crops. The PEIR mistakenly relies upon the study for two reasons. First, the study pre-dated limits of manure applications to crops. Limiting manure to uptake would naturally reduce contamination from crops. The PEIR assumes that corral contamination would continue to equal field contamination after the imposition of application limits. Second, the study’s claims were based on feedlots on silty loam soils. The PEIR reveals that Kings County does not contain silty loam surface soils. PEIR at 4.1-5 through 4.1-7. Therefore, the Elliot study is irrelevant here.

The PEIR’s claim that no corral contamination would occur is not supported by substantial evidence. Neither of the two studies relied upon by the PEIR apply here. The CVRWQCB and the City of Visalia have both studied the corral issue and both conclude that corrals present a huge impact to groundwater quality. The PEIR should be revised and recirculated with analysis of corral-related groundwater impact, not misleading 30 year-old studies.

Two potential mitigation measures exist for corral-related groundwater contamination. Plastic liners could underlay the soil and channel pollutants to a collection system. Another mitigation measure would require support stock be put to pasture. Without corrals, there will be no severe threat to groundwater. This mitigation measure concomitantly addresses PM, emissions from support stock, and odor control, while allowing wastewater application to pasture.

Lagoon Seepage

The CVRWQCB and Visalia studies document wastewater lagoons as sources of groundwater contamination. Policy 4.1a.B.2 of the element allows wastewater lagoon seepage at

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Tulare County Animal Confinement Facilities Plan Environmental Impact Report, Responses to Comments at 31. Attached as Appendix N.
a rate of $1 \times 10^{-5}$ cm/s. The PEIR identified policy 4.1.a.B.2 among policies which would reduce the impacts to groundwater quality to a less-than-significant level. The PEIR states that "calculations were prepared" and claims that results "indicate that salt loading rates at dairy facilities would be on the order of 500 to 1,000 pounds/acre/year." PEIR at 4.3-33. The PEIR does not set forth these "calculations" for public review. The data relied upon by the EIR should be disclosed to the public and decision makers for review. Undocumented "calculations" are not substantial evidence.

The amount of seepage from only wastewater lagoons (this does not include the seepage from corrals) would be tremendous. An expert retained by the Sierra Club, Kathy J. Martin, prepared an analysis of the seepage from the twin Borba dairies in Kern County. Each dairy would house approximately 14,300 total cows for a project total of 28,572. The Borba dairies wastewater lagoons are planned to meet the NRCS standard of $1 \times 10^{-5}$ cm/s, the same standard set forth by Policy 4.1.a.B.2.

Martin calculated that each Borba dairy facility would discharge 65.7 million gallons of manure wastewater into the soil beneath the lagoons annually. Martin calculated that the discharge would lead to severe non-nitrate salt loading. Martin concluded that a lagoon constructed for a 14,200 total cow dairy would discharge 699,896 pounds of Bicarbonate salt per year, 262,650 pounds of Chloride salt per year, and 155,869 pounds of Sodium salts per year. Total non-nitrate salt loading per year would be 1,118,415 pounds.

The total future acreage of dairy facilities in Kings County will likely be 14,573 acres. The remaining capacity in the Kings County dairy herd for future growth is 542,928 total cows, PEIR at 6-6, requiring lagoon capacity equal to 37.9 Borba 14,300 cow dairy facilities. The PEIR claims that salt loading beneath facilities would be between 500 and 1,000 pounds/acre/year. This claim, unsupported by calculations, does not stand up to simple math.

These 37.9 new Kings County Borba style dairies would load a total of 42,387,928.5 pounds of non-nitrate salt per year (1,118,415 multiplied by 37.9). The total acreage of these facilities would be 14,573 acres. Total non-nitrate salt loading would be 29,08 pounds/acre/year (40,374,781.5 divided by 11,453 acres). This loading comes from only the lagoons and does not include salt loading as a result of corral discharges. It goes without saying that crops will not uptake any salt in the facility area.

The PEIR's conclusion that the Element's policies will reduce groundwater

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38Borba Dairies Project EIR at 3-5. Attached at Appendix C.


40Element, Table No. 5.
contamination to a less than significant level lacks any meaningful analysis and public disclosure. The core purpose of an EIR is informed decision making. An EIR's "purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR 'protects not only the environment but also informed self-government.'" Laurel Heights Improvement Assn. v. Regents of University of California (1988) 47 Cal.3d 376, 392.

This PEIR makes conclusory statements regarding salt loading, unsupported by evidence, which actually understate the severity of the impact to groundwater. "A legally adequate EIR must contain sufficient detail to help ensure the integrity of the process of decision making by precluding stubborn problems or serious criticism from being swept under the rug." Kings County Farm Bureau, 221 Cal.App.3d at 733.

Furthermore, the County relies on Policy 6.1h to create a monitoring program to ensure compliance with County regulations. However, the policy defers formation of the implementation plan for water monitoring to the Dairy Monitoring Office which is yet to be established. The County cannot defer the formulation of this policy. Kings County should recirculate the PEIR once monitoring policies are formulated and with supporting authority on how it reaches its conclusion that there will be no groundwater impacts from salt when Kings County plans to add more than half a million cows to its dairy herd. Without this information, the PEIR fails its purpose as an informational document.

V. BIOLOGICAL RESOURCES

Impact 4.4-1: Habitat Destruction

The PEIR claims that conversion of agricultural land to dairy facilities will not affect plant or wildlife resources. PEIR at 4.4-8. This conclusion lacks analysis. The PEIR itself recognizes that the San Joaquin Kit Fox uses agricultural fields as foraging habitat. PEIR at 4.4-4. The U.S. Fish and Wildlife Service considers development of dairy facilities on existing crop land to constitute harm to the Kit Fox. 42

The CEQA guidelines require a mandatory finding of significance where "the project has the potential to . . . reduce the number or restrict the range of an endangered species." CEQA Guidelines § 15065(a). The Endangered Species Act and its implementing regulations prohibit the "take" of a protected species under section 9 of the Act, 15 U.S.C. § 1538. The Miller Letter

41 See discussion in Impact 4:2-5.

42 Letter from Karen J. Miller, Chief, Endangered Species Division, U.S. Fish and Wildlife Service, Department of the Interior, Sacramento Fish and Wildlife Office to Kris Cardoza, Associate Planner, Kern County Planning Department (October 1, 1999) (hereafter "Miller Letter"). Attached as Appendix P.
expresses the opinion of the U.S. Fish and Wildlife Service that the development of dairy facilities constitute an illegal “take” under the Act.

The PEIR needs to consider habitat loss as an impact on the Kit Fox. Potential mitigation would include incidental take permits or actions pursuant to a habitat conservation plan.

Kit Fox and Tipton Kangaroo Rats will populate fallow agricultural fields.43 Plowing or leveling such fields will result in take. The Policy 3.3a of the Element only requires biological surveys for undisturbed habitat. Element at DE-24, 25. The PEIR should require biological surveys for all future dairies and dairy expansions.

Furthermore, the PEIR illegally defers mitigation measures to protect sensitive species. The PEIR vests discretion to mitigate impacts to species to individual biologists employed by facility proponents. The PEIR may not defer mitigation measures,44 nor may the lead agency confer its discretionary authority to impose mitigation measures, and the terms of those measures, to biologists employed by facility proponents. The PEIR should set forth a certain buffer zone and establish a standard mitigation measure when sensitive species are located.

Element Policy 1.2c states that “generally, dairies are prohibited on wetlands and undisturbed wildlife habitat. The PEIR and Element do not define “undisturbed.” The County should clarify whether dairies are unconditionally banned from building facilities on, or applying manure and wastewater to, undisturbed habitat, and wetlands.

A county with well over three-quarters of a million cows will need to have some habitat remaining for native plants and species. The county must consider mitigating dairy development impacts to sensitive species in Kings County, including prohibiting dairy development on undisturbed habitats and allowing “connective corridors” so that population groups do not become genetically isolated.

The Element is a regional program and a regional survey should be conducted to assess the baseline against which impacts should be judged. The PEIR has not sufficiently established a current baseline, relying on a 1975 habitat study. PEIR at 4.3-5. Data that are 27 years old cannot satisfy CEQA’s requirement that a draft EIR includes a description of the “physical environmental conditions . . . at the time the notice of preparation is published.” CEQA Guidelines § 15125(a) (emphasis added). Kings County may not reach conclusions regarding the significance of impacts if it has not established an adequate baseline on which decision makers will weigh environmental impacts. See CEQA Guidelines 15125(c). If current data is not reasonably available, the County must make some, albeit less exacting, effort to provide some

43 Telephone conversation with Dr. Ted Murphy, California State University Bakersfield, January 22, 2000.

44 See section III, supra.
kind of baseline data.

Impact 4.4-2: Wetland Impacts

The Element does not define “wetland.” Thus, it is unclear what “wetlands” Element Policy DE 1.2e will protect. The policy states that wetlands are “generally” protected yet the PEIR assures the public and decision makers that dairy development on wetlands will be prohibited. A clear statement of the wetlands policy needs to be made, and a mitigation measure inserted into the PEIR to prevent loss of wetlands. Moreover, the “wetlands” definition should include seasonal wetlands, vernal pools, and isolated wetlands which are not tributaries to waters of the United States.

VI. HUMAN HEALTH

Pathogen Baseline

The PEIR states that the KCEHS has contracted with Tulare County to perform tests on water wells in Kings County. PEIR 4.8-3. The PEIR does not provide any information on the results of those tests. Thus, the PEIR lacks a baseline against which the public and decision makers can measure and evaluate pathogen impacts. As stated in sections IV, V, and VI, supra, the PEIR must establish a baseline against which it evaluates impacts. The PEIR lacks data on current pathogen levels in Kings County Groundwater.

Pesticide and Insecticide Baseline

The PEIR lacks a baseline against which the public and decision makers can measure and evaluate pesticide and insecticide impacts. As stated in sections IV, V, and VI, supra, the PEIR must establish a baseline against which it evaluates impacts. The PEIR lacks data on current levels of dairy pesticide and insecticide use in Kings County.

Public Exposure to Pesticides

This section of the PEIR omits discussion of hazardous material impacts on the public. Pesticide drift may impact neighboring residents and communities. The PEIR should analyze this impact.

Antibiotics

The PEIR should analyze the impact of antibiotics use on human health. The Natural Resources Defense Council published a report documenting the relationship between the use of
antibiotics in food producing animals and antibiotic resistant disease agents.\textsuperscript{45} The Element calls for Kings County to host 805,978 cows. There is no discussion in the PEIR on antibiotic use at Kings County dairies or its potential health impact on humans.

\textbf{Impact 4.8-1: Hazardous Material Exposures to Workers}

The PEIR discusses the potential for health related impacts to dairy workers. The PEIR does not identify, analyze, or mitigate health impacts from pesticides, insecticides and hazardous substances. The PEIR is an informational document and should contain an analysis of impacts. Without this analysis, the PEIR fails its core function: informing the public and decision makers about the Element’s impacts. There is no analysis of ammonia or hydrogen sulfide exposure to workers.

The PEIR claims this impact will be less-than-significant without analysis. The PEIR states that dairy workers potential for exposure would be similar to farm worker exposure in existing agricultural activities. PEIR at 4.8-7, 8. California’s farm workers face a tremendous health impact from pesticides, including high death rates and pesticide-related illnesses.\textsuperscript{46} Element Policy DE 4.3a only ensures that dairies comply with existing hazardous materials laws and regulations. Farmworker exposure to pesticides occur despite the existence of a regulatory framework.\textsuperscript{47}

The PEIR does not include an analysis of increased use of insecticides to control flies and mosquitos. It makes a conclusive statement that net pesticide use would decrease without setting forth a baseline and identifying both dairy insecticide use and continued agricultural use.

\textbf{Impact 4.8-4: Pathogen Impacts}

The PEIR fails to analyze pathogen impacts through wastewater lagoon and corral seepage.\textsuperscript{48} For lagoons, the PEIR concludes that pathogen impacts will be reduced to a less-than-significant impact through the use of low permeability liners. The PEIR made this conclusory statement without analysis. CRPE has already set forth the fact that manure lagoons discharge millions of gallons of manure wastewater when constructed to NRCS standards. The PEIR did

\textsuperscript{45}See Natural Resources Defense Council, \textit{America’s Animal Factories: How States Fail to Prevent Pollution from Livestock Wastes}, Chapter 1, \textit{Environmental and Health Consequences of Animal Factories}, 1998. Attached as Appendix Q.

\textsuperscript{46}See \textit{generally} Margaret Reeves, et al, \textit{Fields of Poison: California Farmworkers and Pesticides}, 1999. Attached as Appendix R.

\textsuperscript{47}See \textit{generally}, id.

\textsuperscript{48}See comments on Impact 4.3-7.
not discuss corral seepage at all. The PEIR has failed to perform an adequate analysis of pathogen impacts and its conclusion of a less-than-significant impact lacks substantial evidence.

Dairies threaten groundwater and surface water with pathogens. Cow manure contains *E. coli*, salmonella, and *cryptosporidium parvum*. PEIR at 4.8-10. The main factors in pathogen movement through soil is soil type, soil water content, and flow. Additionally, a study shows that *cryptosporidium* oocysts stay in the aqueous phase and do not precipitate out onto the soil surface. This means that the pathogen groundwater threat remains despite distance traveled. *Cryptosporidium* poses a significant threat because “it is not affected by chlorination at levels that are considered safe for water treatment and human consumption” and that *cryptosporidium* oocysts are “long-term survivors” over time. A national study done by the National Health Survey found *Cryptosporidium parvum* oocysts present at 59% of 1,100 dairies surveyed. The threat of pathogen contamination of groundwater and surface water is real and should be further analyzed.

An outbreak of *cryptosporidium* infection represents a significant health concern. In Milwaukee, Wisconsin during the spring of 1993 there was a widespread outbreak of acute watery diarrhea. Symptoms included stomach cramping, vomiting, nausea and fever. The outbreak affected over 400,000 people. *Cryptosporidium* infection happens after consuming water contaminated with animal or human fecal matter.

In healthy people, the infection is self-limited. That is to say, it runs its course. In people who are immunocompromised, the infection can be “unrelenting and fatal.” This threatened

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52Id. at 2678.


population includes the elderly, people undergoing chemotherapy, and people with AIDS. A 1997 study in the American Journal of Public Health analyzed cryptosporidiosis-associated mortality in Milwaukee during the two years following the outbreak. Between April 1, 1991 and March 31, 1995 there were 58 cryptosporidiosis-associated deaths.44 Four deaths occurred in the two years prior to the outbreak while 54 occurred in the post-outbreak period. The report recommends “to prevent future loss of life from waterborne cryptosporidium outbreaks, it is essential to ensure that all person have access to safe drinking water.”45

Impact 4.9-1: Traffic

The PEIR only evaluates the impact from traffic volume. The PEIR needs to disclose the impact to roads the traffic will have. Dairies will generate feed, manure, and milk truck traffic. The weight of these trucks may cause damage to county roads and highways. This impact may cause the County to spend more money on road repair, in effect subsidizing dairy industry expansion. The public and decision makers need to know the extent to which the public will subsidize dairy operations.

A potential mitigation measure for dairy-related road damage would be a levy on milk or feed shipments which adequately compensates the County for road maintenance.

Section 4.10: Public Services and Utilities

The PEIR does not evaluate the amount of electricity dairies consume during operation. Dairies consume so much electricity that, during California’s energy crisis, dairy industry groups petitioned the California Department of Food and Agriculture to increase milk prices to cover the cost of electricity.

Section 4.11: Cultural Resources

The County should incorporate all recommendations set forth in the letters received from California Historical Resources Information System and the Native American Heritage Commission (December 6, 2000). These recommendations, as part of the consultation process, seem to have been ignored. The County should also work with Rob Wood of the Native American Heritage Commission to identify additional cultural resources in the Kings County Area.

CRPE suggests mitigation measures to protect cultural resources. Proponents should survey all new dairy developments prior to any grading or construction. Pre-construction surveys by qualified archaeologists are necessary because construction personnel are not trained to

44Id. at 2033.

45Id. at 2034.
recognized cultural resources. The PEIR needs to do more than just protect known resources and site-specific surveys would meet the letter and spirit of CEQA. Furthermore, if construction personnel are required to identify cultural resources, then the PEIR illegally defers mitigation to those untrained construction personnel.

VII. CUMULATIVE IMPACTS

The CEQA Guidelines set forth the necessary elements for an adequate discussion of cumulative impacts. The PEIR must provide either (1) a list of past, present, and probable future projects, including those outside the control of the agency; or (2) a summary of projections contained in a general plan. See CEQA Guidelines §§ 15130(b)(1)(A), 15130(b)(1)(B). Additionally, the PEIR must also summarize the expected environmental effects of these related projects and conduct a reasonable analysis of the relevant projects’ cumulative impacts. See CEQA Guidelines §§ 15130(b)(2), 15130(b)(3); Kings County, 221 Cal.App.3d at 729.

This PEIR’s cumulative impacts analysis fails to comply with CEQA in every respect. The PEIR does not contain a list of past, present, and probable future projects. The only projects it names are approved and proposed projects in Kings County, not the 149 existing dairies in the County. PEIR at 5-6. The PEIR claims that it “is impractical and unreasonable to identify all individual past, present, or future projects within the eight-county area that may contribute to cumulative air quality impacts identified for the proposed project.” PEIR at 5-8.

Instead the County attempts to quantify the total emissions from dairies in the eight counties. However, the PEIR completely failed to summarize the expected environmental effects and analyze related projects’ cumulative impacts. All the PEIR does is estimate regional air pollutant emissions. Quantification of pollution is meaningless to the public and decision makers if they are not provided key information regarding the effect and impact of that pollution. The PEIR must inform decision makers about the severity of the dairy air pollution problem. The public should be informed about the burden Kings County expects them to bear for the benefit of the dairy industry.

The PEIR only states in a conclusory fashion that cumulative air impacts will be a cumulative significant unavoidable impact. A finding of significance does not obviate the need to analyze the impacts. See City of Carmel-by-the-Sea v. U.S. Dept. of Transp., 123 F.3d 1142, 1160, 1165 (9th Cir. 1997) (cumulative impact analysis violated CEQA when it failed to provide useful analysis of cumulative impact). Kings County cannot shirk its statutory duty with glib findings of significance and claims of impracticality and unreasonableness. CEQA requires a cumulative impact analysis and the PEIR must be revised and recirculated.

Quantification of Air Quality Impacts

The PEIR only quantifies dairy air quality cumulative impacts from dairies. The Element in calculating the theoretical herd size recognized the impacts of other animal confinement
operations. The cumulative air quality analysis should also account for air pollutant emissions from other animal confinement operations, operations which are clearly related projects under CEQA. Failure to do so is a failure to proceed in a manner required by law and a prejudicial abuse of discretion.

Cumulative Water Quality Impacts

The PEIR also fails to analyze cumulative water quality impacts. Instead the County relies on CEQA Guidelines § 15064.7 to adopt thresholds of significance. Kings County erroneously hangs its hat on this section, which does not apply here. Section 15064.7 falls within Article 5 of the CEQA guidelines which covers the initial study. Kings County decided to do an EIR for the Element, and therefore Article 5 does not apply to the County’s study of the cumulative impact analysis.

Rather, CEQA Guidelines § 15130 guides a lead agency’s cumulative impact analysis once an EIR is prepared. “An EIR shall discuss cumulative impacts of a project when the project’s incremental effect is cumulatively considerable, as defined in section 15065(c).” CEQA Guidelines § 15130(a). The definition of cumulative impacts determines whether a lead agency must analyze an aspect of the project in the EIR. Section 15130 provides instances where a cumulative impacts analysis is not required, and section 15064 is not among them. Simply put, the County improperly claims it need not analyze the cumulative impact to water quality.

The County instead relies on thresholds based on the Tulare Lake Basin plan and existing water quality regulations. However, the discussion of cumulative water quality impacts does not discuss the current water quality in Kings County. There is no analysis of the effectiveness of these existing regulations. Without knowing if water quality is being protected currently, the County cannot make the finding that cumulative water quality impacts are less than significant. The County must do an adequate analysis of cumulative water quality impacts. Its failure to do so is a failure to proceed in a manner required by law and constitutes a prejudicial abuse of discretion.

VIII. ALTERNATIVES

The California Supreme Court has described the alternatives and mitigation sections as "the core" of an EIR. Citizens of Goleta Valley v. Board of Supervisors (1990) 52 Cal.3d 553, 564. The project’s objectives serve as the backdrop to the PEIR’s alternatives section.

The PEIR states objectives as (1) evaluate Kings County’s dairy herd capacity from an environmental and economic perspective; (2) provide standards, including mitigation of impacts; and (3) develop and adopt means to bring all dairies into compliance with the Element. PEIR at 3-10, 11.

The County should consider a no-dairy economic development alternative. Many
industries exist in California which provide jobs and economic development without pollution. In other words, the alternatives analysis considers nothing but more dairies in Kings County. Additionally the County should consider and adopt the 50% reduced herd size alternative because it would meet the objectives while mitigating the significant and unavoidable impact. The County should also consider an even greater herd reduction, since a 50% reduction would still have significant unavoidable impacts.

IX. CONCLUSION

The Draft Program Environmental Impact Report fails to meet CEQA’s basic procedural and substantive mandates in nearly every respect. Because the flaws in the EIR render the document inadequate, it should be withdrawn, rewritten, and recirculated for public comment. The Center on Race, Poverty & the Environment and AIR look forward to participating in the public review period at that time. Should the Kings County Board of Supervisors choose instead to certify this woefully inadequate DEIR, the Center on Race, Poverty & the Environment hereby requests to receive a Notice of Determination.

Sincerely,
Center on Race, Poverty & the Environment

Caroline Farrell
Brent J. Newell
Attorneys at Law
NOTICE OF VIOLATION !!

Dear Property Owners,

In response to numerous recent complaints, an inspector visited your dairy at 9240 - 19 1/2 Avenue, Lemoore. During this visit, we observed several serious violations.

When Kings County Zoning Permit # AA 2039 was issued in March, 1983 to allow you to reopen the old, existing dairy, several conditions were required. The permit allowed 160 milk cows, using a separator/sump system already in place. Our inspection shows that you have significantly expanded the size of your herd, and allowed the separator and sump to completely fill up with solids so as to be unusable. Both of these conditions are violations of your operating permit. Most seriously, you have scraped down a field to the south of the dairy facility to a depth of 3 feet or more and diverted your waste water into it, making an illegal waste "lagoon" of nearly 10 acres within 200 feet of neighboring residences and less than 100 feet from State Route 41. There is also a mobile home park 750 feet away.

The Kings County Zoning Ordinance requires new Conditional Use Permits for dairy herd expansions, changes in dairy waste handling and storage facilities, construction of new lagoons and any excavations in excess of 1 1/2 feet in depth. You have apparently done all of these without obtaining any permits or even contacting this agency. The changes you have made are seriously substandard and could be cause for revocation of your permit to operate this dairy.

In order to avoid revocation proceedings and/or other legal remedies, you must contact this agency with plans and designs for how you intend to alleviate the described violations within 10 days. We suggest you work with a professional dairy designer as some of the issues involved are rather technical and will be difficult to address. You must cease pumping waste into the south field as soon as possible and start the Conditional Use Permit process by no later than April 3, 1998.

Please give this matter your immediate attention.

James Radler
Code Compliance Specialist
(209) 582-3211 ext. 2679

Planning Department:
Environmental Health Service
California Regional Water Quality Control
ZV98009

001291
This is your notification of our intention to initiate enforcement action, which could include revocation of your original permit, citation and fines, and/or possible court action to close your dairy, if you have not filed all necessary materials to allow your application to be certified complete by no later than **April 10, 1999**.

I urge you to give this matter your immediate attention.

[Signature]

James Rader  
Code Compliance Specialist  
(559) 562-3211 ext. 2579

cc: Harian Westbrook - 923 Sycamore Avenue, Tulare, CA 93274  
California Regional Quality Control Board - Ken Johnson  
Planning Department - Sandy Roper  
Board of Supervisors - Tony Oliveira  
ZV98009
NOTICE OF VIOLATION

Final Warning!

Reference: Dairy Property, 9200 - 19 1/2 Avenue, Lemoore
APN: 044-261-044 Zone: AG

March 10, 1999

Dear Sir,

In March of 1998, you were notified that your dairy was operating in violation of your zoning permit due to a significant expansion in herd size and changes in waste handling facilities. You responded by meeting with Planning Agency personnel to promise you would apply and complete all requirements for a new Conditional Use Permit for the larger facility. You did file application materials, but were informed that several pieces of additional information would be required before the application could be certified as complete. No action can be taken on an incomplete application. To date, that information has not been submitted and you are continuing to operate illegally.

In January of this year, I spoke with your dairy consultant, who assured me that all required materials would be submitted "within a week or so." That was two months ago and nothing new has been received. You have now been in formal violation for almost one year and this agency continues to receive complaints.

001293
27 March 2000

NOTICE OF VIOLATION

Mr. Manuel Galhandro
9240 19½ Avenue
Lemoore, CA 93245

MANUEL GALHANDRO DAIRY, KINGS COUNTY

We recently inspected your dairy pursuant to a complaint filed with the Kings County Environmental Health Department. The complainant indicated that excessive amounts of wastewater are discharged to your disposal field on the south side of the dairy.

Our inspection indicates that wastewater is not being properly managed at your dairy. Water was observed to be ponded in the southwest corner of your corrals, and wastewater with a Specific Conductance of 6,800 μmhos/cm was observed in your irrigation ditch surrounding your disposal field. It was apparent that you are applying wastewater directly to the field, without blending, and at a time when the crop does not need the moisture. Wastewater poses a threat to the underlying groundwater if it is applied in excess of the assimilative capacity of the plants, or in excess of reasonable loading rates for soil.

An approximately 4-inch PVC pipe leads from your wastewater pond, crosses the on-site canal (supported by a stick), and discharges to a perimeter ditch surrounding your disposal field. This discharge line is susceptible to rupture and poses a threat to water quality. Therefore, the line needs to be rerouted or suspended in a manner that will minimize the threat to water quality, such as supported in a ductile iron pipe that extends to the outside of the canal levees.

You must immediately stop discharging wastewater in a manner that poses a threat to water quality. By 30 April 2000, submit a technical report to our office that describes your waste disposal procedures for wastewater and manure. The technical report must provide the information indicated on the attached CONFINED ANIMAL FACILITY INFORMATION REQUEST FORM, including number of milk cows, total herd size, and total cropland available for wastewater application. If wastewater is to be discharged to neighboring property, a copy of an irrevocable wastewater disposal agreement must be included in the report. The technical report must also include a plan for rerouting or properly suspending the discharge line that crosses the on-site canal.

To assist in the proper management of the wastes produced by your dairy, and to avoid the application of excess nutrients to your cropland, we also recommend that you contact the United States Department of

California Environmental Protection Agency
Mr. Manuel Galhandro

Agriculture. Natural Resources Conservation Service (NRCS) at (559) 584-9209. In many cases the NRCS will assist in the development of waste management plans at no cost to the owner. Their address is:

Natural Resources Conservation Service
680 Campus Drive, Suite "E"
Hanford, CA 93230

You are responsible for providing the technical report regardless of whether NRCS will be able to assist you. If you have questions regarding this matter, please call Cliff Raley at (559) 445-5130.

LONNIE M. WASS
Senior Engineer
RCE No. 38917

Enclosures

cc: Mr. Robert Fry, Natural Resources Conservation Service, Hanford
Mr. Jim Rader, Kings County Planning Department, Hanford
Lemoore Canal and Irrigation Company, P.O. Box 647, Lemoore, CA 93245
17 March 2000

DISCHARGER: Manuel Galhandro

LOCATION & COUNTY: 9240 19 ½ Avenue, Lemoore 93245 (Kings County)

CONTACT(S): Mr. John Galhandro

INSPECTION DATE: 24 February 2000

INSPECTED BY: Cliff Raley (CEG), Matt Scroggins (WRCE)

ACCOMPANIED BY: NA

OBSERVATIONS AND COMMENTS:

1. On 24 February 2000 we received a complaint from the Kings County Department of Public Health that the subject facility was discharging an excessive amount of wastewater to a field on the south side of the dairy.

2. The Galhandro Dairy is ¼ mile southwest of the intersection of 19 ½ Avenue (Highway 41) and Grangeville Boulevard in the SE ¼ of the NW ¼ of Section 28, T.18S., R.20E., M&D&M, and approximately 1.5 miles northwest of Lemoore.

3. DWR data for three wells near the dairy (18S20E34N01M, 19S20E05C01M, and 18S20E19N01M) indicate that the depth to groundwater was approximately 100 feet during 1998 (http://well.water.ca.gov/Exterra/mapwelldata.cfm?SWN=18S20E34N01M&R=1200.365&QUE=198.364&MOVE=0.0).

4. During the inspection, we observed that cows are kept in dry corrals on the north side of the dairy, and in freestalls on the south side. As shown in Photographs Nos. 1 and 2, the freestalls and a feed lane on the south side are flushed to a series of wastewater ponds. Two of the ponds are on the west side of the dairy and the third pond (not visible in Photographs Nos. 1 and 2) is on the south side of the corrals. The wastewater holding system appeared adequate to hold 120 days of wastewater, and all storm runoff through manured areas during a 25-year, 24-hour storm as required by Title 27, CCR, Section 22562(a).

5. As shown in Photograph No. 3, wastewater is discharged to a disposal field on the south side of the dairy. The field appeared to be 40 acres or less, and not adequate to receive the amount of wastewater produced by the dairy. Vegetation was sparse in the field in areas of standing water. A perimeter ditch, shown in Photograph No. 4, contained wastewater with a Specific Conductance of 6,800 μmhos/cm.

6. As shown in Photographs Nos. 5 and 6, a canal traverses the western boundary of the disposal field. An approximately 4-inch PVC pipe led from the wastewater pond, crossed the canal (supported by a stick), and discharged to the perimeter ditch surrounding the disposal field. There was no evidence that wastewater had been discharged to the canal. (The Specific Conductance of the canal water was approximately 350 μmhos/cm upgradient and downgradient from the dairy). However.
the discharge line appeared susceptible to rupture and poses a threat to water quality. Therefore, the line needs to be rerouted around the canal.

7. There is a large area south of the westernmost corrals that collects runoff during storm events (see Photograph No. 7). This corral should be graded to drain toward the flush lane. Mr. John Galhandro wrote a letter, in response to a previous Notice of Violation (NOV, dated 2 July 1998), stating that runoff from this corral is pumped into the wastewater ponds. However, the standing water was not being pumped out during the inspection.

SUMMARY AND CONCLUSIONS:

1. The wastewater holding system appeared adequate to hold 120 days of wastewater, and all storm runoff through manured areas during a 25-year, 24-hour storm as required by Title 27, CCR, Section 22562(a).

2. The dairy does not appear to have sufficient cropland for the amount of produced wastewater.

3. The corrals on the southwestern end of the dairy need to be graded to direct runoff toward the flush lane.

E. Clifford Raley
CEG No. 1992
Photograph No. 1. Gahbando Dairy (2/24/00). This composite photograph, facing east on the left side and south on the right side, shows the feed lane and flushed alley that lead to the wastewater ponds on the right side of the photo. The feed lane runs east-west; Highway 41 is behind the trees on the left side of the photo and runs north-left-south-right.

Photograph No. 2. Gahbando Dairy (2/24/00). This composite photo is a continuation of the panoramic view shown in Photograph No. 1. The view is facing south on the left side of the photo and toward the southeast on the right side. Wastewater is flushed to the pond on the right side of the photo; water and seeds were mixed in a suspended seeder, and then applied to the upper wastewater pond. The pond is then seen from the left side of the photo. The lane on the upper right side of the photo, which is the water surface after the water had been discharged there. The Gahbando Dairy is located in the upper left corner of the photo.
Photograph No. 3. Galhando Dairy (2/24/00). This composite photograph, facing east on the left side and south on the right side, shows the approximately 40-acre disposal field on the south side of the dairy. The field has a perimeter ditch, adjacent to the dirt road shown here. There is also a canal that is piped under a portion of the lot (beneath disced area on the left side of the photo), and flows in a channel that is visible on the right side of the photo.

Photograph No. 4. Galhando Dairy (2/24/00). This is a close-up photograph of the perimeter ditch around the disposal field. The water had a specific conductance of 6,800 umhos/cm (Class 5 > 3,000 umhos/cm, unsuitable for irrigation, D. W. James et al, Modern Irrigated Soils, John Wiley and Sons, NY, 1982).
Photograph No. 5. Gathudaro Dairy (2/24/00). The discharge line from the wastewater pond to the disposal field crosses the canal.

Photograph No. 6. The same line as in Photograph 5 showing discharge line crossing the canal. Note that the line is...
Photograph No. 7. Galhandro Dairy (2/24/00). This photograph shows ponded water near the southwest corner of the corrals. A letter in the file from Mr. John Galhandro indicates that drainage in this area is pumped into the wastewater ponds. In addition to the pond in the foreground, there is a wastewater pond to the right of the ponded area.
Notice of Violation 
and 
Order to Comply

Manuel Galhandro Dairy, 9240 – 19½ Avenue, Lemoore, CA 93245

Since March 23, 1998, you have been operating your dairy at 9240 – 19½ Avenue, Lemoore in violation of your existing County permit #AA2039 and other applicable laws as to herd size, required wastewater disposal area, waste handling and facility expansion. In that time, you have received repeated violation notices from this and other agencies. In spite of those notifications, you have continued to operate in a state of violation, failed to cooperate with efforts to update your permit to reflect your actual dairy facilities and herd size, failed to provide current, irrevocable wastewater agreements and continued to make additional non-permitted physical expansions. The time has long since come to correct these violations.

You are hereby ordered to immediately bring your dairy facility into full compliance with AA2039. This compliance must take the form of a reduction in herd size to the permit limit of 160 lactating cows plus associated support stock.

By May 1, 2000, you must submit to this agency a plan and schedule to bring your herd to permitted size by no later than November 1, 2000, which is the start of the rain season. It is suggested that as a first step, you immediately stop replacing milk cows as they dry out, to allow for an orderly herd reduction. Your plan must give estimates of how many cows can be removed from production and from the facility each 30 days until the permitted herd size is reached. In addition to the required plan and actions, you must submit to this agency copies of any technical reports prepared in response to the Notice of Violation issued by the Regional Water Quality Control Board on March 27, 2000.
Failure to comply with this Notice or to bring your dairy into compliance with AA2039 will result in this matter being brought before the Planning Commission for enforcement action. This could include a variety of measures up to and including complete revocation of your permit to operate a dairy at this location.

WILLIAM R. ZUMWALT
Director

[Signature]
James Rader
Code Compliance Specialist
(559) 582-3211 ext. 2679

cc: Planning Department – J. Beard
Kings County District Attorney’s Office – P. Hart
California Regional Water Quality Control Board – L. Wass
CCDA Environmental Circuit Prosecutor – S. Geis
ZV98009
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**BLUE:**  CUP 98-14 tentative timeline  
**RED:**  Dairy Element and PEIR tentative timeline
APPENDIX

B
DAIRIES AND THEIR RELATIONSHIP TO WATER QUALITY PROBLEMS IN THE CHINO BASIN

California Regional Water Quality Control Board
Santa Ana Region

July, 1990
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SANTA ANA REGION

Board Members:

Anita B. Smith, Chairwoman
William T. Hardy, Jr., Vice Chairman
Charles Bennett
Ira Calvert
Jerry A. King
Tim Johnson
John Leggett
Charles Paskerian
Bill Speyers

Gerard J. Thibeault, Executive Officer

Report prepared by:

Joanne E. Schneider, Environmental Program Manager
Gordon K. Anderson, Environmental Specialist
Robert L. Holub, Senior Water Resource Control Engineer
Gary M. Litton, Senior Water Resource Control Engineer
Robert R. Nicklen, Senior Water Resource Control Engineer, Staff Specialist
Gary D. Stewart, Senior Water Resource Control Engineer
Roger W. Turner, Environmental Specialist, Dairy Coordinator

Special thanks to other Regional Board staff for their help in putting together the final manuscript.
PREFACE

There is growing awareness of and concern about the severe salt imbalance problem now evident in the groundwaters of the Chino Basin. Excess salts (including nitrates) adversely affect the beneficial uses of these waters for municipal, agricultural and industrial supply. The movement of this poor quality groundwater into the Santa Ana River significantly impacts the quality of this surface water body as well. Since the River flows are used to recharge the Orange County drinking water aquifer, the salts contained in Chino Basin groundwaters ultimately affect the quality of water served to Orange County residents. Modeling studies confirm that this salt imbalance problem will increase significantly over time unless appropriate control and/or cleanup measures are successfully implemented.

While there are a number of contributors to this problem, including irrigated agriculture and municipal wastewater discharges, it is clear that dairy operations in the Chino Basin are of overwhelming importance. The Chino Basin contains the highest concentration of dairies found anywhere in the world. The large animal population generates considerable volumes of liquid and solid waste, which contain significant quantities of salts. The Santa Ana Regional Board initiated a regulatory program to address the water quality impacts of the salt loads from dairy operations in 1972. This program has not changed significantly since that time. The severity of the water quality problem now confronting the Region in the Chino Basin demands reconsideration of the Board's dairy regulatory strategy, both in its design and in its implementation.

Accordingly, the Regional Board directed staff to prepare a report which would both describe the present dairy regulatory program and review, in detail, the rationale for the specific strategies employed. This report was prepared in response to that direction.

This report includes a summary of the water quality problems in the Chino Basin, a discussion of possible sources, and a detailed analysis and discussion of the theoretical basis for the Board's dairy regulatory strategies. Finally, the report contains a proposed dairy strategy based on this detailed analysis. The level of detail apparent in the report, and the intensity of staff effort needed to produce it, reflect the severity of the concern about the impacts of dairy operations on water quality, both within and downstream of the Chino Basin.
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I: PROBLEM DESCRIPTION

A. Introduction

As in most of Southern California, the Santa Ana Region is highly dependent on groundwater to meet the needs of an increasing population. The Chino Groundwater Basin is the largest basin in the Santa Ana Region. It is divided into three subbasins, Chino I, Chino II and Chino III (Figure I-1). The Basin covers about 245 square miles and contains about 43 million acre feet (acre-ft) of water, 9.4 million acre-ft of which is producible. The Chino Basin is adjudicated, with the safe yield determined to be 140,000 acre-ft/year. Water extracted from the Basin is divided among three pools, the agricultural pool (primarily dairies), non-agricultural pool (industrial) and appropriative pool (municipal).

The Basin is affected by a long-term adverse salt balance, i.e., more salt enters the Basin than is exported from it. As a result, the total dissolved solids and nitrate quality of the groundwater in the Chino Basin has been deteriorating for many years and is projected to continue to deteriorate.

The groundwater quality of the Chino Basin is of the utmost concern for several reasons. First, groundwater within the Chino Basin is used extensively for municipal, industrial and agricultural supply.
Second, poor quality groundwater (and salts present in unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of a Groundwater Storage Program (Storage Program) proposed by the Metropolitan Water District of Southern California (MWD). Under this Storage Program, 300,000 to 700,000 acre-ft of high quality water from the State Water Project would be stored in the Chino Basin for use in emergency and drought conditions when imported water is either limited or not available. Such a program would be highly advantageous to water purveyors within the Region.

The third major concern is that poor groundwater quality in the Chino Basin adversely affects the quality of water in the Santa Ana River (River) and, ultimately, the quality of water supplied to Orange County residents. A brief explanation of this problem is warranted:

At the southern end of the Chino Basin, approximately 10,000 acre-ft/year of rising groundwater surfaces and enters the River just upstream of Prado Dam. It is estimated that this rising groundwater accounts for 5 to 10 percent of the River base flow, and it has the worst quality of any single input into the River (municipal sewage treatment plant effluents discharged to the River constitute 90 percent or more of the base flow, but are of better quality with respect to TDS and nitrate than rising groundwater). Recent findings from the watershed-wide nitrogen study (see discussion below) indicate that rising groundwater accounts for approximately
30% to 40% of the nitrate measured at Prado and about 50% of the TDS. As the quality of groundwater within the Chino Basin deteriorates, the quality of rising groundwater that enters the River will also continue to degrade. The River flows through Prado Dam and into Orange County, where it is captured by the Orange County Water District for recharge of the Orange County groundwater basin. The River flows constitute approximately 60 percent of the recharge to this basin, which is the primary source of drinking water in Orange County. Thus, poor quality groundwater in the Basin will ultimately have a significant impact on the quality of drinking water in Orange County.

The Regional Water Quality Control Board - Santa Ana Region (Board) and other agencies and parties have made intensive efforts to protect and enhance the quality of the River and, thereby, to protect the downstream municipal supply beneficial uses. The Board has established water quality objectives for TDS and nitrogen (and other constituents) for the River at Prado Dam. To ensure that these objectives are met, the Board has adopted wasteload allocations for both of these parameters. Each point source discharger to the River (i.e. sewage treatment plants) has been allocated a portion of the total nitrogen and TDS wasteloads to the River. These allocations are implemented through effluent limitations in discharge permits issued by the Board (nonpoint sources such as rising groundwater, are also taken into account in the allocation.)
process). This regulatory program has contributed to an overall improvement in the TDS concentration in the River over time. However, monitoring data collected the last several years indicates the water quality objective for nitrogen (10 mg/l total nitrogen (filtered sample)) is now being exceeded. In response to these findings, a $1,000,000 watershed-wide nitrogen study is now in progress under the auspices of the Santa Ana Watershed Project Authority, Santa Ana River Dischargers Association, the Board, MWD and other local agencies. A primary objective of this study is to recommend measures which should be employed to ensure that the nitrogen objective for the River is met. This is likely to include a recommendation for a revised nitrogen wasteload allocation. The effectiveness of any measures which are implemented at sewage treatment plants may well be compromised by inputs of increasingly poor quality groundwater rising into the River from the Basin, unless corrective actions are taken.

B. Groundwater Quality Problems in the Chino Basin

A recent comprehensive evaluation of the quality of groundwater in the Chino Basin was performed by MWD in 1986 as part of an environmental impact report for MWD's proposed Storage Program. Through the initial feasibility study, Interim Environmental Study and Notice of Preparation process, several concerns regarding the proposed Storage Program were identified. These concerns included
groundwater level changes in the Basin and groundwater quality changes in the Basin and the Santa Ana River. As a result, MWD examined historical water quality in the Basin and conducted an extensive sampling program. The data obtained were used in modeling efforts in which the water quality impacts associated with two alternative operational scenarios for the Storage Program were examined. An evaluation of the water quality impacts that would occur in the Chino Basin and the River without the Storage Program was also conducted as a third scenario. The Regional Board's groundwater quality and quantity models (known collectively as the Basin Planning Procedure or BPP) were used for these evaluations. Historically, the BPP has been calibrated only to examine TDS quality impacts. However, for MWD's work, modifications to the BPP were made so that water quality impacts with respect to nitrate could be investigated as well.

MWD found that groundwater quality becomes progressively worse as the groundwater moves south toward the River. Water recharging the groundwater in the Chino I subbasin, in the northern area of the Basin, has a TDS concentration of about 150-200 mg/l, and a nitrate concentration of about 2 mg/l. TDS and nitrate concentrations increase steadily in the direction of the River, reaching 1000+ mg/l of TDS and 200+ mg/l of nitrate in portions of Chino III (1986 data). MWD concluded that the distribution of TDS and nitrate concentrations in the Basin is consistent with waste water discharges associated with historical land uses, and that the
increase in TDS and nitrate concentrations are the result of discharges of agricultural and municipal wastewater.

MWD's evaluation of historic TDS and nitrate quality in the Chino Basin confirmed previous findings that TDS and nitrate concentrations have been increasing in the Basin. Their review of the TDS and nitrate concentrations in the Chino Basin since 1950 indicates an interesting but alarming trend.

In 1950, groundwater in Chino I had a TDS concentration of generally less than 200 mg/l, Chino II about 200-300+ mg/l and Chino III about 300-500+ mg/l (Figure I-2). By 1966, groundwater quality had significantly worsened (Figure I-3). MWD determined that TDS concentrations in pumped groundwater in 1986 were 240 mg/l in Chino I, 333 mg/l in Chino II and 709 mg/l in Chino III. MWD also projected the future TDS and nitrate quality of the Chino Basin using baseline conditions without the Storage Program. The MWD runs for TDS for the year 2000 showed that while the TDS quality of Chino I and Chino II did not significantly change, the TDS quality of pumped water from Chino III rose to 753 mg/l. Projections for the year 2045 showed that the TDS quality in pumped water from the Chino Basin rose to 249 mg/l in Chino I, 408 mg/l in Chino II, and 995 mg/l in Chino III. TDS concentrations in portions of Chino II were shown to be as high as 1000 mg/l, and in Chino III as high as 1600 mg/l (Figure I-4). This information is summarized in Table I-1.
The same water quality trend between 1950 and 2045 is even more evident for nitrate. In 1950, the entire Basin exhibited nitrate concentrations less than 20 mg/l, with much of the Basin less than 10 mg/l. An exception was a small area of groundwater in the southern-central area of Chino II which was about 50 mg/l, exceeding the drinking water standard of 45 mg/l (Figure I-5). Between 1950 and 1986, nitrate concentrations steadily increased, and the area exceeding 45 mg/l gradually enlarged. As with TDS, sampling in 1986 showed dramatic increases in nitrate concentrations, especially in the southern part of Chino II and the northern part of Chino III (Figure I-6). Not surprisingly, these groundwater areas underlie or are down gradient from the dairy area. MWD determined that the average nitrate concentration in pumped groundwater from the Basin in 1986 was 23 mg/l in Chino I, 40 mg/l in Chino II, and 63 mg/l in Chino III. Projections for the year 2000 did not show a significant change in nitrate concentrations in Chino I, but nitrate concentrations in Chino II rose to 49 mg/l and to 98 mg/l in Chino III. Projections for the year 2045 showed that nitrate concentrations in pumped groundwater were 25 mg/l in Chino I, 85 mg/l in Chino II, and 211 mg/l in Chino III. Almost the entire southern half of the Basin was found to exceed the drinking water standard of 45 mg/l (Figure I-7). This information is summarized in Table I-2.
### TABLE I-1

**PUMPED TDS CONCENTRATION PROJECTIONS BY SUBBASIN (mg/L)**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>1950</th>
<th>1986</th>
<th>2000&lt;sup&gt;1&lt;/sup&gt;</th>
<th>2045&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>200</td>
<td>240</td>
<td>239</td>
<td>249</td>
</tr>
<tr>
<td>Chino II</td>
<td>200-300</td>
<td>333</td>
<td>343</td>
<td>408</td>
</tr>
<tr>
<td>Chino III</td>
<td>300-500</td>
<td>709</td>
<td>753</td>
<td>995</td>
</tr>
</tbody>
</table>

1. Model results without the Storage Program.

**SOURCE:** MWD Chino Basin Groundwater Storage Program EIR (1987)

### TABLE I-2

**PUMPED NITRATE CONCENTRATIONS PROJECTIONS BY SUBBASIN (mg/L)**

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>1950</th>
<th>1986</th>
<th>2000&lt;sup&gt;2&lt;/sup&gt;</th>
<th>2045&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>10</td>
<td>23</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Chino II</td>
<td>15</td>
<td>40</td>
<td>49</td>
<td>85</td>
</tr>
<tr>
<td>Chino III</td>
<td>15</td>
<td>63</td>
<td>98</td>
<td>211</td>
</tr>
</tbody>
</table>

2. Model results without the Storage Program.

**SOURCE:** MWD Chino Basin Groundwater Storage Program EIR (1987)
FIGURE 1-2

YEAR 1869
TOTAL DISSOLVED SOLIDS
CONCENTRATION IN PUMPED GROUNDWATER

SOURCE: MID CHINO BASIN GROUNDWATER STORAGE PROGRAM EIR (1987)

LEGEND
+400 CONTOUR OF EQUAL CONCENTRATION (mg/L)
SOURCE: WNE, 1972b
FIGURE 1-4

YEAR 2045
TOTAL DISSOLVED SOLIDS
CONCENTRATION WITHOUT
STORAGE PROGRAM

SOURCE: MDB CHINO BASIN GROUNDWATER
STORAGE PROGRAM EIR (1987)

LEGEND

- 4000 CONTOUR OF EQUAL
  CONCENTRATION (mg/L)

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FIGURE 1-6
NITRATE CONCENTRATION IN PUMPED GROUNDWATER

SOURCES: MWD GREAT CUPIND GROUNDWATER STORAGE PROGRAM EPA (1987)

LEGEND
NITRATE CONCENTRATION (mg/L)
EXCEEDING DRINKING WATER STANDARD OF 45 mg/L.
These model evaluations provide valuable information with respect to surface water quality in the Santa Ana River as well as groundwater quality in the Chino Basin. The model runs indicate that the nitrogen concentrations in the Santa Ana River will increase from 9 mg/l (1985) to about 22 mg/l of nitrogen (NO₃-N) (99 mg/l as nitrate) by the year 2000, far exceeding the water quality objective for total nitrogen of 10 mg/l. Poor quality groundwater rising into the River from the Chino Basin is a significant contributor to this problem; as noted earlier, recent sampling in the River (1988) as part of the watershed-wide nitrogen study showed that rising groundwater accounted for about 30% to 40% of the nitrate measured at Prado.

The findings of other BPP work which has been conducted over the years are consistent with MWD's results. Model runs executed in conjunction with the development and update of the 1975 and 1983 Basin Plans projected continued deterioration of groundwater quality in the Chino Basin over time. The Regional Board and SAWPA are currently coming to the end of a three year Basin Plan update study (1987-1990). A baseline BPP run was performed at the outset of the study (a baseline run is an extension into the future of present water/wastewater management conditions; the results of this run form the basis for developing and evaluating alternative water and wastewater management strategies): the results again project water quality degradation in the Chino Basin. The baseline run
shows that TDS quality in the Chino II groundwater subbasin will increase from 347 mg/l to 387 mg/l by the year 2015, about a 12% increase (Figure I-8). TDS in the Chino III subbasin is projected to increase from about 700 mg/l to 915 mg/l (31% increase) (Figure I-9). Alternative strategies to address this problem have been evaluated in the course of both prior and current Basin Plan update work. The results of some of these alternative analyses will be described later in this section.

It should be noted that the Chino Basin Watermaster has recently completed the first year's sampling of a comprehensive monitoring network which includes 198 wells. Of these 198 wells, 67 were selected primarily to cover the agricultural area south of the Pomona Freeway. The data obtained from this sampling effort support the BPP projections. The data show high nitrate and TDS concentrations in shallow wells in many areas of the Basin. Some deep wells also show elevated nitrate and TDS concentrations. This poor quality groundwater (and additional salts now in transient in the unsaturated zone) will, sooner or later, adversely affect the groundwater basin as a whole, as indicated by the BPP.

Before moving to a discussion of the possible sources of this severe water quality problem, a final note with respect to the BPP work conducted to date is appropriate. As was stated previously, historically, the BPP was calibrated only for TDS; Basin Plan update model work through 1988 focused solely on TDS water quality.
projection. To explore the various potential water quality impacts of implementation of their proposed storage program, MWD had modifications made to the BPP such that nitrate impacts in the Chino Basin specifically could be examined as well. More recently, the BPP was actually calibrated for nitrate (and TDS) so that impacts can be explored throughout the Upper Santa Ana and San Jacinto Basins. This work was conducted as part of the watershed-wide nitrogen study. The revised BPP provides more reliable projections of nitrate quality than MWD's work (since the BPP was calibrated for nitrogen) and will substantially enhance the Region's planning capabilities.
FIGURE 1-9
GROUND WATER QUALITY
CHINO III SUBBASIN

TDS (MG/L)


070 720 740 780 820 880 920

- BASELINE
+ W. Q. OBJECTIVE

SOURCE: SAWSA/CDS BASH PLAN UPDATE
TASK REPORT (1989)
C. Sources of Groundwater Degradation in the Basin

As noted earlier, the sources of groundwater degradation in the Basin include agricultural and municipal waste waters; the areas exhibiting the worst degradation reflect these historical land uses. But while irrigated agriculture and municipal wastewater disposal are certainly contributors to the degradation, it is evident that dairy wastes play an overwhelmingly significant role in waste loads discharged to the Basin. As early as the 1970's, it was well recognized that the application of dairy manure and dairy washwater was threatening underlying groundwater quality (Adriano et al., 1971; Pratt et al., 1972; Pratt et al., 1976a; Pratt et al., 1976b). These studies documented high concentrations of nitrate and salt within the soil profile underneath dairies within the Basin dairy area (Adriano et al., 1971; Chang et al., 1973).

The relative significance of dairies as contributors to the groundwater quality problem is evident if one compares the salt loads which result from these operations to those from other types of land use. These comparisons can be made using data from the BPP. A detailed discussion of the BPP is not possible or appropriate here. Suffice it to say that a critical first step in the model operations is the calculation of the salt waste loads which result from various land uses. The model performs these calculations by multiplying land use acreages in various categories

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(e.g., dairies, irrigated agriculture, etc.) by salt loading factors (unit factors) which are specific to each type of land use. (A more detailed discussion of this computational step is provided in Appendix A). These salt load data are then entered into the quality model portion of the BPP and projections of ground (and surface) water quality can be made over time.

Staff took two comparative approaches, both using BPP salt input data, to investigate the relative significance of dairies as salt contributors. One analysis was conducted using data from the 1983 Basin Plan update BPP runs. For the second analysis, data from the recent calibration of the BPP was utilized. Each of these analyses is discussed below.

In the first approach, staff analyzed BPP data used in the 1983 Basin Plan update BPP runs. The salt loads to groundwater which were calculated for the year 1990 for the Chino Basin dairy area (which included about 19,300 acres of agricultural land and about 1,900 acres of residential-commercial-industrial land) are shown in Table I-3. Note that agricultural land use accounts for about 97% of the salt load added to groundwater.

---

'The 1983 model runs show the Chino dairy area to be contained in two Water Supply Agency areas (these are artificial agencies used for modeling purposes). These agencies are No. 371 (called the "West of Corona City") and No. 381 ("South of Ontario"). The "agency" boundaries are depicted in Appendix C.
To determine the amount of salt added to the groundwater by dairy operations in the Chino dairy area relative to other agricultural land uses, staff made changes to the model input and portions of the model were rerun. Specifically, the dairy salt unit factor was set to zero (from 2.4 tons salt/acre/year), while the other unit factors were left unchanged. The results show that about 88% of the agricultural salt load within the dairy area is due to dairy operations (Table I-4).

Under the second approach, staff analyzed data on historical salt contributions to the Chino Basin by various types of land use, including dairy operations. Data used in the recent BPP calibration indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 are presented in Table I-5. This data represents salts that are added to water as a result of use and that will reach groundwater. Salt additions as a result of consumptive use (concentration of salts as a result of evaporation and/or transpiration) are not included. Note that this table includes data for land uses in the Chino I, II and III groundwater subbasins), as well as land uses in the Cucamonga subbasin area (this area is much larger than that considered in the first analysis described above (the Chino Basin dairy area)).


<table>
<thead>
<tr>
<th>Land Use</th>
<th>Wastewater Returns AF/Y</th>
<th>Salt Added Tons/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential/Commercial</td>
<td>778</td>
<td>697</td>
</tr>
<tr>
<td>Agricultural</td>
<td>20,013</td>
<td>22,725</td>
</tr>
<tr>
<td>Industrial</td>
<td>43</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23,439</td>
</tr>
</tbody>
</table>

**TABLE I-4**

**AGRICULTURAL WASTE LOADS**
Salt Added to Groundwater (Tons/Acre/Year)

Total Dissolved Solids (mg/l) for year 1990

<table>
<thead>
<tr>
<th>Original Waste Load</th>
<th>Revised Waste Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Waste Load = 2.4 T/A/Y</td>
<td>Dairy Waste Load = 0.0 T/A/Y</td>
</tr>
<tr>
<td>22,725</td>
<td>2,756</td>
</tr>
</tbody>
</table>

Agricultural wastewater with dairies: 22,725 T/A/Y
Agricultural wastewater w/out dairies: 2,756 T/A/Y

Agricultural wastewater due to dairies:

\[22,725 - 2,756 = 19,969\]

\[19,969/22,725 \times 100 = 88\%\]

...agricultural salt unit factors assumed for "dairy...
<table>
<thead>
<tr>
<th>Year</th>
<th>1966-67 (tons)</th>
<th>1967-68 (tons)</th>
<th>1968-69 (tons)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>139,942</td>
<td>17</td>
<td>139,942</td>
<td>17</td>
</tr>
<tr>
<td>60</td>
<td>488,876</td>
<td>51</td>
<td>488,876</td>
<td>51</td>
</tr>
<tr>
<td>0</td>
<td>27</td>
<td>0</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>54,735</td>
<td>6</td>
<td>54,735</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>38,532</td>
<td>5</td>
<td>38,532</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>49,738</td>
<td>12</td>
<td>49,738</td>
<td>12</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total:**
- Native Vegetation
- Special Improvements
- Urban Outlets
- Dilapidated
- Non-Intergared
- Intergared
- Citrus
- Irrigated Field Crops
- Non-Intergared Field Crops

**Land Use:**
- 1958-1966
- 1966-67
- 1967-68
- 1968-69

**Table 1-5**
Table I-5 shows the tons of salt added to the Basin by each of nine (9) different land use types, and the percentage of the total salt load contributed by each of these uses. It can be seen that dairy land use (#6) appears to account for 51% of the salt added to the Basin between 1958 - 1986. Adjusted data on salt load additions and the percentage contributions by each land use type are also shown in this Table. These adjustments are necessary because of a problem with the way dairy acreage is accounted for in the BPP. In the BPP, dairy acreage is considered to include only those areas occupied by dairy animals; the BPP does not accurately reflect the total acreage affected by dairy waste disposal practices (e.g. cropland). To account for this, the salt loads associated with non-irrigated field crop acreage (land use #1) and a portion (38%) of irrigated crop acreage (land use #2) where dairy wastes are presumed to be applied were added to the dairy (land use #6) figure (see footnote #3 on Table I-5). When the data are adjusted in this way dairy land use accounts for 60% of the total salt added to Chino Basin groundwater from 1958 to 1986. [Note that this percentage differs from the 88% figure previously presented for dairy salt contributions; this difference is due to size of the area considered in each analysis (Chino Basin versus only the Chino Basin dairy area).]

Another method of demonstrating the relative significance of dairy salt loads was also employed in the preparation of this report. A special BPP model run was performed for the Board by James M.
Montgomery Engineers, Inc., using the newly calibrated model. This run was conducted to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in the Basin and the land was used instead for other types of agriculture. This simulation was performed by assuming that the dairy land use in the model was replaced by irrigated agriculture\(^1\). The model run was conducted for the period 1990-2015\(^2\), and the results were compared to the so-called baseline run for the same period. The baseline run was conducted as part of the ongoing watershed-wide nitrogen study and assumes the present pattern of dairy land use.

The differences between the special model run, without the dairy waste load, and the baseline run at the end of the 25 year planning period (2015) are shown in Tables I-6 (a) and (b) and I-7 (a) and (b). Table I-6 (a) and (b) show the decrease in concentrations of TDS and nitrate, respectively, which result from the removal of

\(^2\)To perform this simulation, the TDS and nitrate loading unit factors utilized in the model for dairy land use were replaced with the unit factors for irrigated field crops. (Irrigated field crop salt unit factors are lower than those for dairies). (Salt loading unit factors and their application in the BPR are described in detail in Section III and Appendix A).

\(^3\)To make water quality projections beyond the year 1990 based on this revised land use scenario, it was first necessary to establish the groundwater quality conditions (initial conditions) that would have existed in the Basin in 1990 had dairies never been in operation in the Basin. This was done by running the calibration model, which utilizes data for the period 1960 - 1986 (substantial dairy land use began in the Basin about 1958), with the same changes to the unit factors described in footnote 2, above.
the dairy operations. These concentration decreases apply to pumped water quality (or available water). The amount of available water in storage that is affected by the concentration decrease is shown in the tables. When the concentration data is considered together with the volume of water affected, it is evident that the dairies have a significant effect on the quality of groundwaters, particularly in the Chino II and III subbasins.

Tables I-7 (a) and (b) show the decrease in the mass of TDS and nitrates in the Chino Basin which result from the removal of dairy operations. The change in TDS and nitrate mass observed applies to the total water in storage (also shown in the tables). It is evident from this data also that dairy operations have a significant impact on Chino Basin water quality.
**TABLE I-6(a)**

Difference in Total Dissolved Solids Concentration Between Baseline and "Without-Dairy", Model Runs After 25 years of Simulation (Year 2015).

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Total Dissolved Solids Concentration Decrease (mg/l)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>2</td>
<td>3.8 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>32</td>
<td>4.6 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>45</td>
<td>1.3 million</td>
</tr>
</tbody>
</table>

**TABLE I-6(b)**

Difference in Nitrate Concentration Between Baseline and "Without-Dairy", Model Runs After 25 Years of Simulation (Year 2015).

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Nitrate Concentration Decrease (mg/l)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>2</td>
<td>3.8 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>8</td>
<td>4.6 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>12</td>
<td>1.3 million</td>
</tr>
</tbody>
</table>
### TABLE I-7(a)


<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Total Dissolved Solids Mass Decrease (tons)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>30,069</td>
<td>20.7 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>382,976</td>
<td>18.8 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>193,195</td>
<td>3.2 million</td>
</tr>
</tbody>
</table>

### TABLE I-7(b)


<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Nitrate Mass Decrease (mg/l)</th>
<th>Volume Available Water (AF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chino I</td>
<td>21,561</td>
<td>20.7 million</td>
</tr>
<tr>
<td>Chino II</td>
<td>103,607</td>
<td>18.8 million</td>
</tr>
<tr>
<td>Chino III</td>
<td>43,118</td>
<td>3.2 million</td>
</tr>
</tbody>
</table>

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Table I-8 provides a summary of pertinent data with respect to the Chino Basin dairy area. It is generally accepted that dairies in the Chino Basin represent the largest concentration of dairies in the world. Data compiled from the 1988 Annual Reports submitted to the Board by the dairy operators show that, within an area of about 15,000 acres (Figure I-10), there are approximately 300 dairies in the Basin which contain about 289,600 animals. These animals produce about 460,000 tons (dry weight)/year of manure, of which about 246,578 tons appears to be discharged ultimately within the Chino Basin. (As will be discussed elsewhere in this report, there is no definitive information on the fate of most of the manure generated in the Chino Basin). The total manure generated in the Chino Basin correlates to 132,020 tons/year of salt per year, of which 14,720 tons is nitrogen (as N) (Webb, 1974). On the order of 70,768 tons of salt appear to remain in the Chino Basin each year, of which about 27,631 tons reaches groundwater (see Appendix B).
**TABLE I-8**

CHINO BASIN DAIRY DATA SHEET

**NUMBER OF DAIRIES IN THE CHINO BASIN IS APPROXIMATELY 300**

**NUMBER OF ANIMALS IN THE CHINO BASIN DAIRY AREA**

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking Cows</td>
<td>166,900</td>
</tr>
<tr>
<td>Dry Cows</td>
<td>33,300</td>
</tr>
<tr>
<td>Heifers</td>
<td>39,400</td>
</tr>
<tr>
<td>Calves</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>289,600</strong></td>
</tr>
</tbody>
</table>

**MANURE DISTRIBUTION IN THE CHINO AREA 1988**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total corral manure production</td>
<td>460,000 Tons</td>
</tr>
<tr>
<td>Amount of manure reported spread on disposal land</td>
<td>11,100 Tons</td>
</tr>
<tr>
<td>Amount of manure stockpiled</td>
<td>16,500 Tons</td>
</tr>
<tr>
<td>Amount of manure spread on croplands associated with dairies</td>
<td>45,500 Tons</td>
</tr>
<tr>
<td>Amount of manure reported hauled away</td>
<td>387,200 Tons</td>
</tr>
<tr>
<td>Amount of manure received by composters</td>
<td>70,355 Tons</td>
</tr>
<tr>
<td>Amount of manure hauled by others</td>
<td>316,845 Tons</td>
</tr>
<tr>
<td>Amount of manure hauled out of the Chino Basin by others (assumed 1/2 of the above)</td>
<td>158,422 Tons</td>
</tr>
<tr>
<td>Amount of manure reported by composters to be hauled out of the Chino Basin</td>
<td>55,000 Tons</td>
</tr>
<tr>
<td>Amount of manure remaining within the Chino Basin</td>
<td>246,578 Tons</td>
</tr>
<tr>
<td>Resulting amount of Salt (TDS) being discharged within the Chino Basin</td>
<td>70,768 Tons</td>
</tr>
<tr>
<td>Amount of Salt (TDS) reaching Chino Basin ground water (applied over 15,000 acres) (see Appendix B)</td>
<td>27,631 Tons</td>
</tr>
</tbody>
</table>

'1Data compiled from 1988 Dairy Annual Report

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D. BPP - Alternative Analysis

The results of all model simulations described earlier, whether from the Regional Board's Basin Planning efforts or through the work of other agencies such as MWD, indicate similar conclusions. Excessively large salt loads have been entering the ground as a result of waste discharges from dairies. These salt loads, with their high nitrate concentrations, appear to have impacted and certainly will continue to impact groundwater in the Chino Basin and, ultimately, surface water quality in the Santa Ana River. In order to prevent, or at least minimize, this water quality degradation, it is clear that measures must be considered to reduce the dairy waste loads (TDS and nitrate), as well as methods that could be employed to remove salts already present in the groundwater. Such alternatives were considered in the 1975 and 1983 Basin Plan update work. Alternatives are also being considered as part of the current Basin Plan review. The alternatives that are now being evaluated with the BPP include a reduction in the dairy salt waste load (which might be accomplished through additional manure removal and/or washwater removal (see Section III of this report)) and the removal of salts now in the groundwater through the operation of desalting facilities in the Chino II and Chino III subbasins. Unfortunately, these alternative runs include other assumed water/wastewater management strategies (e.g., increased reclamation in specific areas of Chino Basin) which complicate the interpretation of the model results. That is,
it is not possible to distinguish the water quality impacts of the measures described above from those of other components of the alternative run. Ideally, additional, more specific model runs will be conducted if resource constraints will allow it. Nonetheless, it is clear from the alternative analysis that has been conducted that, irrespective of any other measures which might be implemented to address water quality problems in the Chino Basin, the construction and operation of desalters will be absolutely essential. Perhaps the most significant effect of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. The Santa Ana Watershed Project Authority is already pursuing the implementation of these facilities. Experience with desalting operations elsewhere in the Region (the Arlington desalter) and recent desalter feasibility studies indicate that the cost of these desalters will be on the order of $320 - $690 for every ton of salt removed.

E. Other Considerations

Groundwater Quality Data:

There is another important consideration with respect to the BPP projections discussed above which warrants separate attention. This pertains to the water quality data used for input into the BPP.
The data on which the modeling projections are based were derived from available sampling results from a limited number of wells within the Chino Basin. Although this information is sufficient to conclude that significant degradation is occurring in the Chino Basin, a clearer understanding of the extent and nature of this degradation is needed for future planning and mitigation activities. Some of the best available information was obtained in 1986 when MWD sampled 148 wells in the Chino Basin. However, there are currently over 500 wells in the Chino Basin, and existing groundwater data is limited to only a portion of these wells with many years separating sampling events.

In recognition of the need to obtain data from more wells on a more frequent basis, several agencies are expending resources to obtain more reliable groundwater data in the Chino Basin. The Santa Ana Watershed Project Authority has contracted with a consultant to determine where data gaps exist in the Chino Basin; the Chino Basin Watermaster has expedited efforts to improve its sampling program, and MWD will be developing a monitoring program with local agencies in the event MWD proceeds with its proposed Storage Program.

Throughout the Santa Ana Region, the Regional Board requires waste dischargers to monitor the quality of their discharges and the quality of the receiving water body. However, this has not been the case with dairies, all of which are operating under waste
discharge requirements. In order to remedy this situation, Regional Board staff contacted the Milk Producers Council and the California Milk Producers in early 1989, and requested their assistance in developing a groundwater monitoring program for dairies within the Santa Ana Region. The Regional Board could amend waste discharge requirements to include a monitoring program for each dairy, resulting in the need for each dairy to sample existing wells or to install monitoring wells on their property to assess the impacts their waste discharges are having on the underlying groundwater. However, this may be more extensive than what is actually necessary, and Regional Board staff believed that a more limited, efficient, and less expensive program could be developed and implemented in the dairy area under the direction of the two major dairy organizations in the Chino Basin. Despite the apparent advantages of such a program, the Milk Producers Council has refused to participate in this endeavor. The California Milk Producers (CMP) board also declined to fund the monitoring work because members outside the Chino Basin did not want to pay for monitoring solely within the Basin. However, the CMP has actively worked with the engineering contractor who will be sampling wells within the dairy area to identify the wells which must be sampled within the Chino Basin to evaluate dairy impacts. CMP has also actively lobbied the Chino Basin Watermaster to sample the above-described wells. In addition, CMP has volunteered to provide previously unreleased groundwater quality data which were generated in the recent past.
The Watermaster completed its first sponsored Basin-wide monitoring program for the Chino Basin in April 1990. The monitoring program included the dairy area wells as well as a representative sample of wells throughout the Basin. It is anticipated that this program will be continued.

Additional discussion regarding the need for a comprehensive groundwater monitoring program is to be found later in this report.

**Surface Water Quality Problems:**

The preceding discussion of water quality problems in the Chino Basin focused primarily on groundwater, although the significant effects of rising groundwater on Santa Ana River quality was also described. Dairy operations can also affect surface waters within the Chino Basin, and the Santa Ana River in a more direct fashion. Runoff of dairy washwater or stormwater which have come into contact with manured areas adversely affects the quality of those surface waters.

As described later in this report (Section III), the Board has adopted requirements on dairy operators which are designed to prevent these impacts. These include requirements for the containment of all washwater and all storm water runoff from
manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Unfortunately, these containment controls are not always constructed or maintained properly by the dairy operators, and discharges of wastewater to local surface drains occur. This surface water drainage problem is exacerbated in some areas by the extensive urban development occurring upstream of the dairy area. The significant increase in impervious surfaces associated with this urban development causes the amount and velocity of storm water runoff entering parts of the dairy area to increase dramatically. This, in turn, significantly affects the integrity of the containment controls implemented by the dairy operators and, therefore, the dairy operators' ability to comply with their waste discharge requirements. A number of studies have been conducted to determine effective solutions to this problem. Specific recommendations for the control of surface water impacts from dairy operations, in part based on the results of these studies, are included in the dairy strategy which is proposed at the end of this report.
II. DAIRY REGULATION IN THE SANTA ANA REGION: A BRIEF BACKGROUND AND OVERVIEW

In the 1950's, the center of the dairy population in Southern California was in Los Angeles County. There was, for example, a concentration of dairies in Torrance. Short haul distances had led the dairymen to locate there initially, but urban crowding soon induced them to move elsewhere. Many of the dairies that left the Los Angeles metropolitan area relocated in the unincorporated communities of Dairyland and Dairy Valley in southeastern Los Angeles County and western Orange County. Most of Orange County was still largely undeveloped and agricultural in the late 1950's and early 1960's.

Orange County urbanized rapidly in the 1960's and '70's. Pressure on operating dairies from encroaching urban development takes several forms: odor and nuisance complaints increase, runoff from additional paved areas leads to greater drainage problems, and traffic becomes a problem. Increases in land value, however, tend to make the necessary relocation easier and more acceptable. In addition, each time a dairy facility is rebuilt, there is an opportunity to improve on the design and increase efficiency.

Several dairies stayed on in Orange County as long as they could, but by the late 1970's, they were essentially all gone. Some of
the dairies scattered, but a great many relocated in the Chino Valley, a very attractive location for a number of reasons. It was generally warm and dry, reasonably level for the most part, and had nice morning and evening breezes. Land was reasonably priced, since it was farther from the centers of urban pressure. The haul distance to the creameries was longer than it had been, of course, but Chino was still a very acceptable compromise.

Historically, dairy corral design called for a slope away from the milk barn, usually toward the nearest stream or ditch. That way, when it rained in the winter, the milk barn stayed dry and excess manure was washed out of the corrals and off the property. From the point of view of the dairyman, there was no manure management problem with that arrangement. A number of the dairies established in the Chino area were built that way.

The very wet winter of 1968-69 made it clear that the dairies could not be allowed to continue to use local surface waters to dispose of their manure. When the storms ended and the water behind Prado Dam receded, the sight and smell of a great many tons of dairy manure were both obvious and overwhelming. This was one of the influences that motivated the Regional Board staff to begin thinking of ways to control the impacts of the dairies.

In 1972, the first sets of waste discharge requirements for the dairies were adopted by the Regional Board. It was felt that the
first, easiest and most reasonable step in the control strategy was to manage and prevent runoff from corrals and manured areas. Once that was under control, the rates of application and/or disposal of manure could then be limited as the second step. The third and most difficult phase, if it could be achieved, would be total control of all waste materials through limits on wash water disposal.

The dairy community argued successfully that they could not fairly be held responsible for all rainfall circumstances and conditions, and a compromise formula was developed. At a minimum, dairies would be responsible for installing and maintaining runoff control facilities (dikes, berms, ponds, etc.) to address 24-hour rainfall events which were less than or equal to 1.3 times the 10-year storm (equal to the 25-year, 24-hour storm event). Despite the intent of the Regional Board staff, this formula had only minor effects on most existing dairy operations. A low berm was generally put up across the lower side of the property, and the subject was dismissed. Where it did have an effect, however, was when a new dairy was being designed, or an existing dairy was trying to come into compliance.

Multiplying the manured area (corrals and stockpile areas) times the rainfall figure allowed dairymen to calculate how much water they had to manage. Appropriately-sized retention ponds and disposal areas could be designed using the formula. Because of
steeper slopes and other features related to the location of some properties, however, there were still some dairies that found it difficult, if not impossible, to control storm-induced runoff, flooding, and other such problems.

In the process of developing the data and information needed for the computer modeling necessary to produce the 1975 Basin Plan, Albert A. Webb and Associates was contracted to study waste disposal in the dairy industry. Board staff worked closely with Webb and with the Santa Ana Watershed Project Authority (SAWPA), the Board's basin plan contractor, to develop acceptable salt loading rates from dairies and other agriculture (see Section III and Appendix A). The manure disposal limit that appears in the waste discharge requirements issued to the dairies, three tons per acre per year, resulted from those efforts. As the next section of this report discusses in detail, the objective in specifying the three tons per acre per year limit was to ensure that the dairy salt load was reasonably comparable to that from other land uses (e.g., urban and agricultural uses).

Manure is the major waste disposal problem at most dairies. Corrals are convenient, in that they keep the cows close to the barn; milking, feeding and watering are more efficient, as are the necessary routine veterinary procedures. But the manure is concentrated in a much smaller area where nothing grows, and it has
to be cleaned out, or at least scraped and piled, a couple times a year.

Permits that limited manure disposal to 3 tons/acre/year quickly made it clear to the dairymen that agricultural application at 10 to 20 tons/acre/year made a lot more sense, since they removed a lot more manure than simple disposal could. This issue will be covered in detail later in this report.

As a hydrologic system, the Chino Basin is closed. Water, salt and/or pollutants discharged to the ground in the Chino Basin move down toward Prado Basin and appear as rising water flows in the Santa Ana River. What has kept these pollutants from showing up sooner is a combination of the slow movement of these materials down through the unsaturated zone, and the slow movement of groundwater toward the River. Knowing that the impacts of waste disposal from the dairies would appear sooner or later, and that this activity would have serious water quality effects if it were unregulated, SAWPA and the Regional Board proposed during 1975 that the area be sewered and the wastewater flows be treated. The wastewater would then have been discharged to the Santa Ana Regional Interceptor (SARI), the brine line, effectively exporting the washwater salts to the ocean.

The SARI line was approved by EPA, but the scheme to sewer the dairy area was not. EPA reportedly felt that sewer ing this
agricultural area would benefit the dairy industry, and would make urbanization much more likely to occur sooner. They did not want to encourage growth. This threat of growth must have seemed to EPA to be more serious than the threat to water quality. The ramifications of this failure to adequately address washwater disposal will be discussed in detail in a later section of this report.

In summary, the Regional Board dairy regulatory program developed in the early '70's addresses surface water protection through runoff controls and groundwater quality protection by means of limits on manure application rates. This program remains essentially unchanged today. The water quality problems described earlier in this report indicate that changes in this regulatory program are necessary. To understand these changes, a more detailed review of the rationale for specific aspects of the Board's requirements is necessary. That will be the focus of the next section of this report.
III. THE DEVELOPMENT OF THE REGIONAL BOARD’S DAIRY REGULATORY PROGRAM

A. Introduction

Manure wastes generated at dairies are temporarily or permanently deposited in areas that may impact both surface water and underlying groundwater. These areas include the corrals, washwater holding ponds, pasture, and croplands associated with the dairies. As described previously in this report, the Regional Board has established waste discharge requirements for dairies to protect surface and groundwater quality. These requirements are summarized in Table III-1. As shown in this Table, the Board’s regulatory program addresses surface water protection through requirements for the containment of all dairy washwater and manured storm water (up to and including the 25-year, 24-hour storm), and for protection from 100-year storm flows which would inundate manured areas. To protect groundwater quality, the Board’s requirements limit the application of manure to pasture (also known as disposal acreage (see Subsection C)) and croplands. Note that specific information is obtained from the dairy operator when a new or substantially modified dairy operation is proposed; annual reports submitted by the dairy operators allow Board staff to assess compliance with waste discharge requirements. To date, the Regional Board has not implemented any requirements to prevent groundwater degradation.
TABLE III-1

SUMMARY OF THE CURRENT DAIRY REGULATORY PROGRAM

Santa Ana Region

REPORTS OF WASTE DISCHARGE

- Name, address, phone number, etc
- Proposed animal population
- Dairy, disposal land, and cropland acreage
- Plot plan (sketch) of the dairy and disposal areas
- Proposed method(s) of manure disposal
- General description of proposed wastewater disposal method and containment controls

WASTE DISCHARGE REQUIREMENTS

Surface Water Protection

- Containment of all washwater and storm runoff from up to and including a 25-year, 24-hour storm
- Protection from inundation from 100-year peak stream flows

Groundwater Protection

- 3 tons/acre of manure on disposal land
- Agronomic rates for manure application to cropland

ANNUAL REPORTS

- Name, address, phone number, etc.
- Animal population
- Dairy, disposal land, and cropland acreage
- Manure disposition (amount spread on disposal land, spread on cropland, stockpiled, or hauled away)
- Types of crops grown (if manure was spread on cropland)
- Hauler's name and location where manure was hauled
- Type of wash water disposal method used
- Statement regarding problems encountered during previous year
from manure deposition in corrals or from the application of nutrients and salts deposited on the soil by the application of the dairy wash water to pasture. The following sections provide a detailed discussion of the rationale for each of these aspects of the Board's dairy regulatory program.

It should be noted that a significant portion of the manure that is generated by the dairies is reported to be transported away from the dairy areas; some is even hauled outside of the Santa Ana Region (see Chino Basin Dairy Data Sheet, Table I-6). Manure waste deposition in these areas can also pose water quality problems, however, the Board has not implemented any requirements to address such impacts. Any effort to do so would require the implementation of a manure accounting system to track the fate of manure wastes generated within the Region. This issue will be addressed in a later section of this report (see Section IV).

B. Dairy Operations

In order to understand the rationale that the Regional Board has employed to protect ground and surface waters from wastes generated by the dairies, it is first necessary to review the typical operation of the dairies, the sources and types of wastes generated, and typical disposal methods.
Most of the animals at an efficiently operated dairy will consist of milking cows which are maintained in corrals most of the time. Much of the waste generated by these animals remains in the corrals until it is removed on approximately a semiannual basis. The manure deposited in the corrals undergoes various degrees of decomposition, and since most of the corral floors are earth, the salts and nutrients that are present in dairy manure are subject to transport into and through the underlying soil of the corral by the infiltration of precipitation and moisture from fresh manure.

Dairy cows are typically removed from their corral twice each day for milking. Webb (1974) reported that approximately ten percent (10%) of the manure generated by milking cows is deposited in the water which is used to wash the cows prior to milking. Manured wash water is applied directly to pasture or cropland or is stored in a pond and then applied to pasture/cropland. Pond capacities generally prevent long-term storage of the manured wash water, and thus, the wastewater generated each day is usually applied to the agricultural land on a daily basis.

Approximately twice a year, the manure that has accumulated in the corrals is removed and applied to pasture and/or cropland or hauled away from the dairy. Pasture and cropland also receive the dairy wash water, which, as stated above, contains approximately 10%

1The term manure, as used in this report, includes all feces and urine excreted from the dairy cattle.
percent of the total waste generated by the milking cows. A small percentage of dairies employ a "flush out" waste disposal system for their corrals. At these dairies, manure is routinely washed out of the corrals with water, routed to a holding pond and applied to pasture and cropland.

A typical dairy will also support nonmilking cows, replacement dairy cows, heifers and calves. When the condition of the pasture will allow (sufficiently dry with substantial grass), these animals are commonly maintained on pasture. Thus, the pasture will receive the manure excreted from these animals. However, much of the pasture also receives dairy wash water and manure from the corrals, which adds to the salts and nutrients applied to these lands.

For the purpose of understanding the relative proportion of lands that are being subjected to temporary or permanent manure deposition, the following table shows the amount of land in the Chino Basin dairy area used for corrals, pasture, and croplands:
Table III-2

Dairy Manure Land Use Within the Chino Basin Dairy Area

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acreage</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops and Hay(^1)</td>
<td>6,700</td>
<td>45</td>
</tr>
<tr>
<td>Pasture(^1)</td>
<td>6,280</td>
<td>42</td>
</tr>
<tr>
<td>Corrals(^2)</td>
<td>2,000</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,980</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

\(^1\)SCS (1988). Pasture = disposal acreage (see Subsection D)

\(^2\)Estimated from the 167,000 milk cows present in the Chino Basin dairy (Regional Board staff 1988 dairy survey) and assuming that each cow requires approximately 500 ft\(^2\) of corral area.

Thus, it appears that of the land which comes in contact with manure in the Chino Basin dairy area, approximately 45 percent is used for crops and hay, 42 percent is pasture and 13 percent has been developed as corrals.
C. Regional Board Dairy Requirements

The rationale for the Regional Board's surface water protection requirements is clear: washwater (which, again, contains about 10% of the total manure generated by milking cows) and stormwater runoff which has come into contact with manured areas must be contained on site in order to prevent adverse impacts to local and downstream surface waters. Surface runoff of such wastes in the Chino dairy area can ultimately affect the Santa Ana River. The Board's requirements are consistent with all the other extensive efforts being made to control water quality in that critical water body.

In the following subsections, those requirements which pertain specifically to groundwater quality protection are discussed in detail relative to the dairy land use identified above (Table III-2).

D. Pasture or Disposal Land

As previously noted, the Regional Board has specifically limited the amount of manure that can be applied to "disposal land" to 3 tons of manure (dry weight) per acre per year. This manure disposal requirement was developed in the early 1970's. At that
generated by dairies and the amount of salt from those wastes that would be expected to migrate to underlying groundwater (University of California Committee of Consultants (UCCC, 1973a; UCCC, 1973b)). Using this information, the amount of manure that could be applied to achieve the 0.3 ton/acre/year salt loading rate to groundwater was calculated to be 3 tons manure (dry weight)/acre/year (Appendix B).

In summary, then, in establishing the 3 tons dry manure/acre/year disposal requirement, the Regional Board's intent was to implement a regulatory mechanism which would limit the amount of salt leaching to groundwater from dairy operations to 0.3 tons/acre/year, consistent with other permitted salt loading rates. It is imperative to understand that, in order to achieve this salt loading objective, two things were required (and assumed):

The first requirement was that there be 100% compliance with the manure disposal requirement (3 tons/acre/year). Clearly, lack of compliance (i.e., manure application in excess of 3 tons/acre/year) results in salt loads in excess of the desired 0.3 tons/acre/year. The information provided in the 1987 Dairy Annual Reports submitted by the dairy operators indicated that there was good (95% or so) compliance with the manure disposal requirement. However, the fate of most of the manure generated is not clear. (The need for an improved reporting system to document the fate of manure within the...
Region will be addressed in a subsequent section of this report.) If it is assumed that 50% of the manure is removed from the Chino Basin (an assumption which staff believes is rather generous) and the remainder is deposited within the Basin, the effective salt loading rate to groundwater from manure application alone was closer to 2 tons/acre/year.

The second requirement (and planning assumption) was that all dairy washwater be removed from the dairy area. As discussed earlier in this report (Section II), the third phase of the Board's proposed dairy regulatory strategy was the removal of dairy washwater from the area by sewerage. At the time the manure disposal requirement was imposed (early 1970's), it was assumed that this phase would be implemented and that, therefore, no salt loading from washwater would occur. The maximum dairy salt load of 0.3 tons/acre/year could then be achieved. However, sewerage of the washwater was not found to be feasible. No other equally suitable mechanism for washwater disposal has been identified or implemented to date. As described earlier, washwater continues to be applied daily to pasture and/or cropland as the primary means of disposal. Webb (1974) estimated that about 10% of the waste generated by a dairy cow is excreted in the washwater; therefore, washwater application results in an additional salt loading to groundwater of about 0.41 tons/acre/year.
It should be noted also that, at the time the manure disposal requirement was adopted, it was assumed that the application of manure as a fertilizer on cropland would not result in salt loads to groundwater in excess of typical, nondairy agricultural rates. As will be discussed below (Subsection F), this assumption was not justified.

Cumulatively, the effect of the degree of manure removal (about 50%) and the continued application of washwater in the dairy area results in a salt loading rate to groundwater of about 2.4 tons/acre/year, which is 8 times the salt loading unit factor sought by the Regional Board for the dairy industry\(^1\). This is summarized in Table III-3, below. Possible methods of addressing this excessive salt loading problem are discussed in a subsequent section of this report (Section IV).

\(^1\)As noted in Appendix A (unit factors), detailed model calibration work has been performed to update unit factors in conjunction with the watershed-wide Nitrogen study. Two recommendations regarding dairy salt unit factors have resulted (James M. Montgomery, Engineers, 5/1989 SAWPA Task Report). Montgomery found that the 2.4 tons/acre/year unit factor developed based on estimates of dairy waste removal (see Table III-3) was correct for historic dairy land use. But a salt unit factor of 2.54 tons/acre/year was recommended for present dairy operations.

\(^2\)Note from Appendix A, Table A-1 that the 2.4 dairy unit factor is 8 or more times the unit factors for other agricultural land uses and is 5 times the factor for residential and commercial uses (inside and outside).
TABLE III-3

Salt Loading to Dairy Area (Pasture + Corrals)  
(tons/acre/year)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Actual</th>
<th>0.3</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 tons manure/acre/year</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Wash Water</td>
<td>0.0</td>
<td></td>
<td>0.41</td>
</tr>
<tr>
<td>Total</td>
<td>0.3</td>
<td></td>
<td>2.41</td>
</tr>
</tbody>
</table>

*Assumes approximately 50% removal of dairy manure.

It must be emphasized that the figures shown in this Table for actual dairy salt loading are estimates (which recent model calibration studies have independently confirmed). In particular, the reporting system presently used to track manure disposal compliance is not sufficient to document the fate of all manure generated in the dairy area. As stated at the outset of this section, the fate of the manure that is reported to be hauled away is not known. An improved manure tracking system is necessary to accurately identify the salt loading to groundwater that can be attributed to dairy operations.

Certain issues have been raised concerning manure application on disposal land. It is appropriate to discuss these issues before moving to the discussion of the rationale for the Board's regulatory program with respect to dairy cropland and corral areas.

III-12

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It has been recently debated whether pasture should be considered as "disposal land" or as "cropland", which is permitted a larger manure application rate (12 dry tons/acre/year). It is argued that nitrogen uptake in pastures is at least equivalent to that in cultivated croplands, and that, therefore, a higher application rate of manure should be permitted on pasture. It is true that from the standpoint of nitrogen removal, a bermuda grass pasture in good condition will take up approximately 225 pounds of nitrogen per acre, which is similar to many other nonlegume forage crops and exceeds the nitrogen requirements of most field crops (i.e. barley, oats, corn, and wheat). Thus, from a nitrogen removal standpoint, a bermuda grass pasture, in good condition, will utilize nitrogen as much as other plants, which are considered to be crops. An even greater nitrogen uptake rate can be realized if the pasture is seeded with a winter grass to facilitate the utilization of nutrients on a year-round basis. However, an inspection of the Chino Basin dairy area provides insight as to why pasture has always been considered as disposal land and not cropland. In many cases, dairy manure is simply applied to the land without any effort to cultivate a pasture and the land remains fallow throughout the year since it is not seeded and irrigated. In other cases, marginal bermuda grass pastures have developed, but, during the winter months when the bermuda grass becomes dormant, no annual grasses are seeded to carry the pasture over to take up salts and nutrients in the manure applied during the winter. Under some
conditions, the pasture is irrigated with manured wash water, but is not seeded, which only promotes weed growth. The weeds are simply plowed under before the next application of manure. Under these conditions, crops are not consistently cultivated to remove the nutrients in the applied manure. These practices seem to be the rule rather than the exception, and for these reasons, staff continues to consider all pasture as disposal land. Moreover, as discussed above, pastures already receive additional nitrogen inputs through the application of dairy wash water.

E. Corral Areas

To date, the Regional Board has not regulated the deposition of manure waste in corral areas. Corral areas compose approximately 13 percent of the land that comes in contact with dairy manure and large quantities of manure are permitted to accumulate between corral cleanings. Since the manure contains substantial quantities of salts and nutrients, it is logical to assume that underlying groundwater quality is significantly threatened by the leaching and subsequent infiltration of these constituents into the underlying soils. However, while it may appear that the salt and nutrient loadings from corral areas are a significant source of dairy manure contamination, several studies suggest otherwise.
Nitrate and salt in soils underlying corrals, pasture and cropland in the Chino Basin dairy area was studied by Adriano et al. (1971). Soil borings were performed in corrals, pasture, croplands, and in undisturbed areas. The highest concentrations of nitrate and chloride measured in saturated soil extracts were observed beneath the corral area at depths to 9 meters (100 ppm NO₃-N, 1000 ppm Cl), as compared with pasture concentrations (35 ppm NO₃-N, 100 ppm Cl), cropland concentrations (25 ppm NO₃-N, 50 ppm Cl), or background concentrations (10 ppm NO₃-N, 15 ppm Cl). However, the concentrations of nitrate and chloride in the shallow groundwater (approximately 11 to 17 meters beneath the ground surface) collected at each of the 15 sites was greater under the pasture (5.27 ppm NO₃-N, 7.09 ppm Cl), when compared with corrals (4.10 ppm NO₃-N, 3.88 ppm Cl), cropland (3.21 ppm NO₃-N, 2.86 ppm Cl), or undisturbed background concentrations (1.86 ppm NO₃-N, 3.15 ppm Cl). It was concluded that corrals contributed more nitrates than pasture or cropland on a unit area basis, but that the area of corrals constitutes only 5 percent of the total land area available for irrigation (this report has estimated 13 percent of the land subject to the application of manure). Therefore, Adriano et al. (1971) suggested that the mass of salts and nutrients leaching from cropland or pasture is greater since the land area is much larger.

The leaching of salts from corrals can also be expected to be less than pasture and cropland because irrigation water is not applied to the corral areas. Only precipitation that falls directly within
the corrals or rainfall runoff that enters the corrals and infiltrates into the underlying soil will transport salts and nutrients to the underlying groundwater. Thus, salt and nitrate movement is probably much slower below corrals when compared with transport of these constituents through the soil from pasture or croplands. The soils under corrals are also heavily compacted from the continuous load of the dairy cows, which may reduce the hydraulic conductivity of the soil (and, therefore, the transport of salt and nitrate) significantly (Chang, 1973).

To date, the Regional Board has not regulated the deposition of manure in the corral areas because the contribution of salts and nitrates to groundwater from these areas is small compared with the leaching of salts from pasture and croplands.

F. Croplands

Within the last few years, the Regional Board has implemented a requirement limiting manure loading to croplands to agronomic rates. As a general rule of thumb, staff considers application rates in excess of 12 tons/acre/year to be of concern, unless the dairyman can demonstrate that more manure is required to meet the agronomic needs of the crops. The 12 tons/acre/year "flag" was implemented by staff because 12 tons of manure meets the necessary
nitrogen requirements of many double cropped land management scenarios employed within the Santa Ana Region.

Figures III-1a and III-1b present the estimated salt (TDS) and nitrate loading to the groundwater and the amount of nitrogen applied to the soil for manure application rates varying from 0 to 24 tons/acre/year. The TDS loadings were determined using the rationale developed by the University of California Water Quality Task Force, Committee of Consultants (UCCC), as presented by Webb (1974) (see Subsection D, p.III-8 and 9; Appendix B). The regression equation used for the computation of these loadings is shown in Appendix B. As shown in Figure III-1b, the total nitrogen applied each year to the soil is approximately 400 lbs. N/acre at the 12 ton/acre manure application rate. The loading rate of nitrogen assumes that 50 percent of the nitrogen present in the fresh manure has volatilized. This total nitrogen application rate appears to be sufficient for many double crop management systems such as oats-sudan grass or barley-corn. However, it is possible to cultivate crops which require more nitrogen such as the combination of barley in the winter and sudan grass in the summer. Triple cropping has also been reported in some instances. The utilization of nitrogen by crops commonly cultivated in the Santa Ana Region are listed Table III-4.
TABLE III-4

Nitrogen Utilization by Various Crops*
(Western Fertilizer Handbook)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pounds Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>160</td>
</tr>
<tr>
<td>Oats</td>
<td>115</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>250</td>
</tr>
<tr>
<td>Sudan grass</td>
<td>325</td>
</tr>
<tr>
<td>Alfalfa²</td>
<td>480</td>
</tr>
</tbody>
</table>

*Total uptake in harvested portion.

²Legumes are capable of fixing nitrogen from the atmosphere and, therefore, actual application of fertilizer can be significantly less.

As shown above, a winter crop of barley combined with a summer crop of corn (silage) requires approximately 400 lbs. of nitrogen. Similarly, sudan grass and oats need approximately 440 lbs. of nitrogen.

There is concern by staff that the use of manure on cropland, even at agronomic rates, may not be protective of underlying groundwater quality. Specifically, the concern is that the use of manure to meet the nutrient requirements of crops results in the excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater. This concern is described in more detail below.
Dairy manure contains much more salt per unit of nitrogen than other types of chemical fertilizers. A comparison of the types of fertilizer that might be applied to land and their respective salt content is informative. Table III-5 presents the salt content of three fertilizers that might be utilized.
### Table III-5

Comparison of Salt Compositions in Fertilizers

Pounds of salts per 100 lbs. of Nitrogen

<table>
<thead>
<tr>
<th>Ion</th>
<th>Regional Mix</th>
<th>15:15:15 Blend</th>
<th>Dairy Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>0</td>
<td>147</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>0</td>
<td>292</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>80</td>
<td>28</td>
</tr>
<tr>
<td>Cl</td>
<td>8</td>
<td>73</td>
<td>82</td>
</tr>
<tr>
<td>SO₄</td>
<td>45</td>
<td>173</td>
<td>123</td>
</tr>
<tr>
<td>HPO₄</td>
<td>14</td>
<td>143</td>
<td>188</td>
</tr>
<tr>
<td>NO₃</td>
<td>359³</td>
<td>443</td>
<td>443</td>
</tr>
<tr>
<td><strong>Total Salts</strong></td>
<td><strong>584</strong></td>
<td><strong>912</strong></td>
<td><strong>1,370</strong></td>
</tr>
<tr>
<td>Nonnitrogen Salts</td>
<td>225</td>
<td>469</td>
<td>927</td>
</tr>
<tr>
<td>Non Nitrogen/ Total Salts Ratio:</td>
<td>39%</td>
<td>52%</td>
<td>68%</td>
</tr>
</tbody>
</table>

¹For the purpose of developing a salt loading unit factor for agricultural uses other than dairies, a regional fertilizer mix was formulated on a weighted basis using fertilizers commonly used within the Region (WRE, 1970). See Appendix A for additional discussion.

²40% ammonia sulfate, 33% diammonium phosphate, 25% muriate of potash, and 2.5% urea.

³Soil microorganisms uptake and volatilization of ammonia were estimated by WRE (1970) to reduce this value from 443 lbs. to 359 lbs. Volatilization losses for the 15:15:15 Mix and dairy manure were accounted for before application to land and microorganism uptake was assumed to be negligible.
As shown in Table III-5, dairy manure contains much more salt per unit of nitrogen (68%) than either the 15:15:15 fertilizer mix (52%) or the regional mix (39%). The 15:15:15 mix was specifically selected for comparison because it represents a chemical fertilizer with a relatively high salt index. On the basis of fertilizer applied to the land, dairy manure contains at least twice as much total salt as commercial fertilizers. The regional fertilizer mix has less than half of salts contained in the high salt index 15:15:15 mix and one-fourth of salts present in dairy manure. The regional mix consists primarily of urea and anhydrous ammonia which are referred to as high analysis fertilizers. Generally, high analysis fertilizers exhibit lower salt indexes, and the prudent use of such fertilizers may result in much less salt applied to agricultural land.

Not all of the salt that is applied to land from fertilizer will leach to the groundwater table. Plants will take up significant amounts of nitrogen and, to a much lesser degree, some of the other salts contained in the fertilizer. Some of these other salts will precipitate to form relatively insoluble compounds that remain in the soil. On the order of one-half of the salts originally applied to the soil will be transported to the groundwater; the actual amount depends on a variety of factors which can be considered in a computer model. Staff conducted some model simulations to evaluate the amount of salt which leaches to groundwater from each of the three fertilizer types identified above. The modelling
techniques employed are described in Appendix A (Model Evaluation of Salt Leaching from Fertilizers). The results of the simulations are summarized below:

Figure III-2 presents the total salt (TDS) loading rates for dairy manure, the 15:15:15 fertilizer blend, and the regional fertilizer mix relative to the amount of nitrogen applied to agricultural land. Table III-6 exhibits the data which were used in Figure III-2. As shown in Figure III-2, the dairy manure salt loading rate to the groundwater table is approximately twice as much as the salt loading rate for the high salt index 15:15:15 blend and four times as great as the regional mix. For applications of fertilizers at application rates common for the Chino Basin dairy area, the relationship of application rate and groundwater loading rate is relatively linear. Thus, increases in the amount of fertilizers applied to the soil will result in a proportionate increase in the amount of salt entering the underlying groundwater aquifer.

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Total Nitrogen Application Rate (lbs. N/acre/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>0.48</td>
</tr>
<tr>
<td>15:15:15 Blend</td>
<td>0.29</td>
</tr>
<tr>
<td>Regional Mix</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Table III-6
Total Salt Loading Rates (tons/acre/year) vs Fertilizer Types

III-23

001380
A second evaluation was performed to determine the amount of nonnitrogen salts leaching to groundwater for the three fertilizer types. This evaluation was performed by subtracting out the nitrogen from the total salt loading factor. For these fertilizer types, the amount of nitrogen (nitrate) leaching to groundwater was similar for the total nitrogen application rates considered. Figure III-3 presents the nonnitrogen salt loading rates to groundwater. The specific loading rates used to generate Figure III-3 are exhibited in Table III-7. Again, the comparison shows that the application of dairy manure to the soil results in a much higher loading rate for nonnitrate salts when compared with the other fertilizers. In addition, by comparing Figures III-2 and III-3 it can be observed that approximately 25 percent of the total salts leaching to the groundwater are nitrogen, which will be in the form of nitrate. For the other fertilizers, the amount of nitrogen leaching beyond the root zone is approximately 50 percent of the total salt load. This is not surprising since dairy manures contain significantly more salt than other types of the fertilizers.
Nonnitrogen Salt Leaching vs Fertilizer Type

Nonnitrate Salt Loading Rate (tons/acre/year)

Nitrogen Application (lbs N/acre/year)

Dairy Manure

15:15:15 Blend

Regional Mix

Figure III-3

III-26

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Table III-7

Nonnitrate Salt Loading Rates (tons nonnitrate salts/acre/year) vs Fertilizer Types

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Total Nitrogen Application Rate (lbs. N/acre/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>0.37</td>
</tr>
<tr>
<td>15:15:15 Blend</td>
<td>0.18</td>
</tr>
<tr>
<td>Regional Mix</td>
<td>0.03</td>
</tr>
</tbody>
</table>

In summary, dairy manure contains much more salt per unit of nitrogen than the other fertilizer types evaluated. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which migrate to groundwater. Based on these findings, staff believes that it is appropriate to consider revising the Board’s present regulatory strategy with respect to manure application on cropland. These and other conclusions and recommendations regarding the Board’s dairy regulatory program as a whole are discussed in a subsequent section of this report.

Before moving to this discussion, it is appropriate to emphasize an important point regarding the preceding discussion. The salt loading unit factors described here and in Appendix A are used in the Region’s computer models (the BPP) to make projections of water
quality over time. These projections, in turn, have proven extremely useful in identifying optimal waste management and regulatory strategies (which have been incorporated in the Basin Plan and implemented through waste discharge requirements). But it should not be construed from this that our knowledge of dairy waste impacts on groundwater quality in the Region is a truly exact science. The figures given for salt loading to groundwater from present dairy operations are estimates, based largely on the information submitted in the dairy annual reports. As previously noted, the information submitted in the annual reports is not adequate to identify the fate of all the manure generated and potentially disposed of in this Region. Because of this inadequacy, our understanding of the real impacts to groundwater of dairy waste management and disposal practices, both within the dairy area per se and elsewhere in the Region, is necessarily limited. This signals the need both for an improved manure disposal tracking and reporting system and for a comprehensive groundwater monitoring program so that more accurate, in the field knowledge of the impacts of dairy operations on groundwater quality can be obtained (and used to refine our chief basin planning tool, the BPP). Additional discussion regarding these needs is to be found in the final section of this report.
IV. SUMMARY AND PROPOSED REGULATORY STRATEGY

As stated earlier in this report, the Regional Board's dairy regulatory program has not changed significantly since its inception in 1972. Based on the findings presented herein, Board staff believes that it is imperative to consider methods of addressing the excessive salt loads which result from dairy operations. Clearly, such methods could include substantive modifications of the Board's regulatory approach. Staff has developed a proposed dairy regulatory strategy which should allow the dairy industry to continue doing business while at the same time protect surface and groundwater resources. To put the proposed measures in context, it is worthwhile to review the salient points made in the preceding sections of this report.

Summary of Key Points

1. There is a severe groundwater quality problem with respect to TDS and nitrate in the Chino Basin. Modelling projections show that TDS and nitrate concentrations will continue to increase significantly over time. Both the Chino II and Chino III groundwater subbasins lack assimilative capacity for additional salt inputs.
2. This groundwater quality problem causes three major concerns:

   a. High nitrate and TDS concentrations adversely affect the use of Chino Basin groundwater for municipal, agricultural and industrial supply.

   b. Poor quality groundwater (and salts now present in the unsaturated soils overlying the groundwater aquifer) may adversely affect the implementation of MWD's proposed Storage Program.

   c. Poor quality groundwater in the Chino Basin ultimately rises into the Santa Ana River, significantly affecting surface water quality. Recent studies (watershed-wide nitrogen study) show that rising groundwater accounts for approximately 30% to 40% of the nitrates measured at Prado Dam and about 50% of the TDS. Since Santa Ana River flows are used to recharge the Orange County drinking water aquifer, poor quality rising groundwater from the Chino Basin ultimately affects the quality of waters supplied to Orange County residents.

3. Recent Basin Plan update modelling studies have shown that the construction and operation of groundwater desalters will be necessary to address this groundwater quality problem. SAWPA is already pursuing the implementation of these
facilities in conjunction with other agencies. A primary effect of the operation of these desalters will be to retard the movement of poor quality groundwater into the Santa Ana River. It is estimated that the cost of desalter operations will be in the range of $320 to $590 for every ton of salt removed.

4. It is evident that while irrigated agriculture and municipal wastewater disposal have contributed to this groundwater quality problem, dairy wastes play an overwhelmingly significant role:

a. Basin Planning Procedure (BPP) results (1983 model runs) show that agricultural land uses account for about 97% of the salt load added to groundwater in the Chino basin dairy area; dairies account for about 88% of this agricultural salt load.

b. Basin Planning Procedure (BPP) data indicate that dairy waste discharges account for about 50% of the total salt load added to groundwater in the Chino Basin as a whole between 1958 and 1986.

c. A special model run was made in order to determine what the groundwater quality conditions in the Chino Basin would be if the dairies were not in operation in
the Basin. This model run shows that the dairies have a significant effect on the quality of groundwater, particularly in the Chino II and III groundwater subbasins. The removal of dairy operations results in significant decreases in both the concentrations and total masses of TDS and Nitrate.

d. Based on data compiled from the 1988 Dairy Annual Reports, dairies in the Chino Basin area generated a total of 132,020 tons of salt (see Chino Basin Dairy Data Sheet (Table I-8)). Of this amount, approximately 70,768 tons per year are estimated to remain in the Chino Basin. Using the regression equation described in Appendix B, approximately 27,631 tons of this salt load will reach Chino Basin groundwater per year. Note that if we assume that the cost of a desalter is $320 per ton of salt removed, the total cost of removing this dairy salt load to groundwater would be roughly $8.8 million per year. This would be the cost to mitigate only the impacts of ongoing operations, not historic impacts.

5. The Regional Board's dairy regulatory program, developed in the early 1970's, includes requirements for both surface water and groundwater protection (see Table III-1).
In formulating groundwater protection requirements, the Board's intent was to ensure that the dairy salt load to groundwater was reasonably comparable to that from other land uses (urban, other agriculture, etc.), that is, approximately 0.3 tons salt/acre/year (this is roughly equivalent to the 230 mg/l mineral increment permitted at that time). To reach this objective, the Board limited manure disposal on disposal acreage to 3 tons (dry)/acre/year. It was thought that this limitation would meet the Board's salt loading objective for dairies, provided that:

a. There would be 100% compliance with the manure disposal requirement (3 tons/acre/year); and,

b. All dairy washwater would be removed from the dairy area. (Wash water contains about 10% of the total salt load generated by dairy operations.)

It was assumed in the early 1970's that the application of manure as a fertilizer on cropland would not result in salt loads in excess of nondairy agricultural rates. However, this assumption was not justified (see §6, below).

6. Within the last few years, the Regional Board has implemented a requirement limiting manure application to croplands to agronomic rates. Staff's recent analysis of this regulatory
approach indicates that manure application on croplands, even at agronomic rates, is not protective of water quality. Dairy manure contains much more salt per unit of nitrogen than other types of fertilizers. For this reason, the use of manure to meet the nutrient needs of crops results in excessive application of salts which are not utilized by plants and which can, therefore, migrate to groundwater.

7. The actual salt loading rate to groundwater from dairy operations is about 2.4 tons salt/acre/year, or roughly 8 times the Board's objective (0.3 tons/acre/year). [Recent studies (watershed-wide nitrogen study) indicate that the dairy salt unit factor should be 2.54 tons/acre/year]. Several factors are responsible for this excessive salt loading:

a. It is estimated that only about 50% of the manure generated in the dairy area is exported from Chino Basin (while dairy annual reports suggest generally good compliance with the Board's manure disposal limitation, the fate of the remaining manure is not documented. Independent model studies confirm that the estimate of 50% manure removal is reasonable.)
b. No washwater has been removed from the dairy area; wash water (with its associated salt loads) continues to be applied to dairy pasture and cropland.

c. There is ongoing manure application to cropland. Even at agronomic rates, cropland application results in the migration of excess salts to groundwater.

8. The dairy salt unit factor is used in the BPP to make water quality projections over time. These projections have proven extremely useful in identifying optimal waste management and regulatory strategies. But our knowledge of the impacts of dairy waste management and disposal practices on groundwater quality in the Region is not an exact science:

a. The dairy salt loading unit factor used in the BPP is an estimate, based largely on the information supplied in the Dairy Annual Reports. (Recent BPP calibration studies indicate that it is a reasonable estimate). However, this reporting system is not adequate to document the fate of all manure generated in the dairy area. A significant portion of this manure is reported to be hauled out of the dairy area, but the fate of this manure is not known. It is assumed that 50% of this manure remains in the Chino Basin and, thereby, significantly increases the dairy salt load to
groundwater. Because of our incomplete knowledge of manure disposal practices, our understanding of the real impacts of dairy operations on groundwater is necessarily limited. An improved manure tracking and reporting system is necessary to accurately document the fate of the manure (and associated salts) generated in the dairy area.

b. The groundwater quality data used in the BPP to make future quality projections were derived from available sampling results from a limited number of wells within the Chino Basin. While these data are sufficient to conclude that significant degradation is occurring in the Chino Basin, additional data are needed to obtain a clearer understanding of the extent and nature of this problem. Such data would be used to refine the BPP, which, in turn, would be used for future planning and mitigation activities. A comprehensive groundwater monitoring program is necessary to provide accurate, in-the-field knowledge of the impacts of dairy operations on groundwater quality. The implementation of groundwater monitoring requirements on dairy operators would be consistent with established practice for other waste dischargers in the Region.
9. Surface waters within and downstream of the Chino Basin are also adversely affected by dairy operations. This problem results, in part, from inadequate dairy waste management programs, including containment controls. In addition, uncontrolled stormwater runoff from rapidly developing urban areas upstream of the dairy area impacts the integrity of the dairy containment controls that are in place, leading to discharges of manured wastewater to surface waters.

Proposed Dairy Regulatory Strategy

Based on the findings summarized above, staff believes that the following measures should be considered to understand, control and correct the water quality impacts of dairy and other animal confinement operations in the Chino Basin. These measures constitute a comprehensive three-part program: Part I is designed to address the present and future impacts from ongoing dairy activities in the Basin; Part II addresses the impacts from past dairy activities; and Part III addresses the need for improved drainage facilities upstream of and within the dairy area.

It should be noted that the word "dairy" has been used somewhat loosely throughout this report. The impacts of waste discharges from other types of animal confinement facilities (heifer ranches, calf nurseries, beef cattle feed lots, etc.) are similar to those
of dairies. Consequently, any strategy proposed to address the impacts of animal waste discharges in the Chino Basin should apply to all animal confinement facilities, not only dairies. All further references to dairies should therefore be understood to apply to all animal confinement facilities.

Part I - Dairy Waste Discharge Requirements: Impacts of Ongoing Operations

Staff has identified four specific areas in which the Board's present animal confinement facility waste discharge requirement program should be revised and improved to address the impacts of present day discharges of manure and manured wastewater. These are: an improved manure tracking system, an improved groundwater monitoring program, a revision of the manure and wastewater disposal/application requirements, and a requirement for engineered waste management plans to be included as a part of Reports of Waste Discharge. Each of these measures is discussed in detail below:

1. Implement an improved manure tracking and reporting system.
   A manifest system similar to that now used for hazardous waste should be implemented. A sample manure tracking manifest is included as Appendix E. Under this system, written documentation of the amount of manure hauled from a dairy, the hauler's name and the location of final disposal or use as

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001395
fertilizer would be described. The owner/responsible party of the land where the manure is applied would acknowledge its final disposition and return the manifest form to the point of origin (dairy operator). The dairy operator would be required to record this information and submit it annually to the Board. Such a manifest system would significantly enhance staff's abilities to: (1) evaluate the full effects of dairy waste management practices on groundwater quality in the Region; and, (2) determine compliance with present (and future) manure disposal requirements. The implementation of this system would likely have significant resource implications for both the dairy industry and Regional Board staff. Given the severe deficiencies of the present reporting system, staff believes that it is essential to implement this program despite the resource constraints.

This manifest program will require that the dairy operators take much more care and time in accounting for the final disposition of each load of manure reported to be hauled away. The dairy operators may have difficulty in obtaining all of the manifests from the landowners/responsible parties who have accepted the manure. This problem can be corrected if the initial agreement between the dairy operator and the landowner/responsible party identifies the use of the manifest system as one of the conditions for receipt of the manure.
2. Implement groundwater monitoring requirements on dairy operators.

Several options are available to the Regional Board to obtain the comprehensive groundwater quality data which staff believes is necessary for planning and mitigation activities:

1) The Board could include groundwater monitoring requirements in the waste discharge requirements of every dairy operator;

2) The Board could include groundwater monitoring requirements in waste discharge requirements, as in "1" above, but could also specify an option of participation in a cooperative, comprehensive monitoring program conducted by the dairy industry or other parties; or,

3) The Board could forego the incorporation of monitoring requirements in waste discharge requirements provided that a comprehensive monitoring program is in place.

The inclusion of monitoring requirements for each discharger in waste discharge requirements would be consistent with established regulatory practice. However, staff recognizes that a number of agencies (SAWPA, Chino Basin Watermaster, IV-12
MWD) are already developing programs to obtain comprehensive, long-term groundwater quality data in the Chino Basin. The Chino Basin Watermaster has recently completed a monitoring program of the Chino Basin and has proposed to continue this effort next year. In light of these efforts, a cooperative program, whereby the dairy industry would participate in the other agencies' monitoring efforts, appears more appropriate and reasonable than individual dairy operator monitoring.

Staff recommends the second option as the most effective and reasonable compromise; that is, incorporate monitoring requirements in each dairy operator's waste discharge requirements, with the option for in-lieu participation in an established, comprehensive monitoring program. Participation in such a comprehensive program should result in substantial cost savings to the dairy operators. For example, the Watermaster's monitoring program was estimated to cost only $8,000 per year for the entire industry. For the current effort, the Watermaster has provided funding to cover the dairy industry portion of this monitoring.

3. Revise the manure and washwater disposal requirements in dairy waste discharge requirements.

As described previously, the Chino II and III groundwater subbasins lack assimilative capacity for additional salt
inputs. In basins without assimilative capacity, mineral increments are not permitted when regulating waste discharges [1983 Basin Plan (p.4-4) and State Water Resources Control Board Order No. 73-4 (the "Rancho Caballero" decision)]. This means that the quality of waste discharged to such basins must meet Basin Plan objectives. To meet Basin Plan objectives in the Chino Basin and thereby comply with the Basin Plan and the State Water Resources Control Board order, the discharge of manure and washwater, and their application as fertilizer and irrigation water, cannot be permitted. Waste Discharge Requirements must be revised to reflect this prohibition. Again, this would apply to the application of manure and washwater to cropland, as well as to the discharge of these wastes to disposal (pasture) land.

Staff recognizes the practical impediments to the prohibition of manure and washwater disposal/application. It was recognized in the early 1970's that washwater removal would be necessary to meet the dairy salt loading objective, but no practical method for washwater disposal has, as yet, been identified. Similarly, suitable methods/locations for manure disposal have been difficult to identify, although Chino Basin Municipal Water District is now in the process of implementing a manure composting facility which should significantly alleviate manure disposal problems in the Basin. Preliminary information indicates that this facility will have the
capacity to handle approximately 50% of the manure now generated in the basin.

Recognizing that it is likely to be difficult to overcome, in whole or in part, the practical constraints to the prohibition of manure and washwater disposal or application in the Chino Basin, staff believes that it would be appropriate to incorporate an offset provision in the dairy waste discharge requirements. Requirements for participation in offset programs have precedence in the Santa Ana Region; where waste discharges cannot be eliminated or improved in quality, the discharger is required to mitigate the impacts of that discharge through an approved offset program. The same approach could be employed with dairy operators; for every ton of salt that will reach groundwater as a result of continued disposal/application of manure or washwater within the Chino Basin, the dairy operator must remove an equivalent amount of salt through participation in an acceptable offset program. Such an offset could include financial participation in the Chino Basin desalter operations which have been discussed previously.

It should be noted that the offsets required would depend on the dairy industry's success in identifying acceptable methods of manure and wastewater disposal; the more manure and wastewater that is removed from the basin, the less the needed
offset. Manure and wastewater disposal outside of the Basin is likely to be more cost-effective than participation in desalter operations: generally, it's less expensive to avoid a problem than to correct it. A number of disposal opportunities could be explored by the dairy industry:

a) Hauling the manure out of the basin to areas that can assimilate additional salt loading.

b) Financial participation in proposed composting facilities such as the one being implemented by the Chino Basin Municipal Water District. This would be acceptable only to the extent that the composted manure is removed from the basin. Indications from Chino Basin Municipal Water District are that markets for the composted manure to be produced by their proposed facility will be largely out of the Basin.

c) Financial participation in proposed waste-to-energy facilities. (Facilities have been proposed in the past which will convert manure into electricity and discharge the salt and other waste materials in an environmentally safe manner.)

Again, the amount of financial participation by the dairy industry in any of these, or any other methods of reducing
the amount of manure that is discharged, may be considerably less than the cost of extracting the salt from the basin after it reaches groundwater (i.e., through participation in desalters). Note, however, that these manure disposal options do not address washwater; continued washwater application in the Basin will require mitigation through an appropriate offset program.

In summary, staff recommends that the waste discharge requirements for dairy operators in the Chino Basin be revised as follows:

a) Prohibit the disposal of manure and washwater, and their application as fertilizer or irrigation water, in the Chino Basin; and,

b) Incorporate an offset provision, whereby the dairy operator could offset the water quality impacts of continued manure and/or washwater disposal/application practices.

Two things about these recommended changes are important to understand. First, the intent of the changes is to keep pace with ongoing dairy operations to prevent further groundwater quality impacts to the Chino Basin. Second, these changes would not impose any unreasonable burden on the dairy
operators; the operators would simply be required to mitigate the impacts of the salt loads for which they are responsible.

4. Require the preparation and submittal of an engineered waste management plan as part of the Report of Waste Discharge.

It was noted at the beginning of Section III that the Board has implemented specific requirements on dairy operations to protect surface waters. These include requirements for the containment of all washwater and all storm water runoff from manured areas (up to and including the 25-year, 24-hour storm), and for the protection of the facility from inundation by 100-year peak storm flows. Under the Board's current regulatory program, the dairy operator must provide a general description of the proposed containment controls as part of the Report of Waste Discharge. Staff experience in the dairy area indicates that this is not adequate.

Because of limited staff resources, only a fraction of the dairies within the Region have been routinely inspected over the last several years to evaluate the adequacy of the containment controls proposed and implemented by the dairy operators. Even when inspections are conducted, problems with the controls are not always readily apparent; what may appear to be adequate in the field during the dry season may actually
fail to work properly when it rains. Discharges to surface waters may therefore occur. Enforcement actions resulting from these discharges frequently include the requirement that an engineer or other qualified person develop a waste management plan for the facility. This plan must then be implemented by the dairy operator.

It would be far more effective, and more efficient, to require that a properly engineered waste management plan be developed and submitted with the Report of Waste Discharge. This plan would be developed by a civil or agricultural engineer, a member of The West End Resource Conservation District or the Soil Conservation Service, or another qualified individual approved by the Executive Officer. The plan would include an evaluation of the existing waste containment controls and a detailed proposal for the additional containment controls, if any, that would be necessary to insure containment of the wastes generated on the dairy. In addition, the waste management plan would include a description of necessary operations and maintenance procedures [e.g., how often check valves should be left on in various fields, when manure should be removed from holding ponds (if these ponds continue to be utilized), activities necessary to control gopher and/or squirrel problems, etc]. Appendix F contains a sample list of the items that should be included in waste management plans. A stipulation would be included in the waste discharge
requirements that the author of the waste management plan inspect the site facilities during construction and at the completion of construction to verify that the waste containment controls were built according to the recommended plan.

This requirement for an engineered waste management plan would be in effect for all animal confinement facilities requiring the submittal of a Report of Waste Discharge (new facilities, as well as existing facilities where the herd size has increased, the type of operation has changed, or the operators have changed). In the case of a change in operators, the submittal of an engineered plan developed by the previous operator would be acceptable, as long as there is no material change in the operation (i.e., herd size remained the same).

The implementation of this plan should significantly reduce the frequency and magnitude of surface water discharges from dairies, in addition to protecting water quality. This would have the advantage of reducing staff expenditures on enforcement actions. The Board has recently acted on a number of dairy Administrative Civil Liability complaints resulting from illegal manured wastewater discharges. In each case, the fine was suspended provided that the operator submit and implement an engineered waste management plan. Had this plan been developed and implemented earlier, the discharges and
subsequent enforcement action need not have occurred. This recommended approach is consistent with the recommendations of the Department of Water Resources in comments on proposed dairy waste discharge requirements (see Appendix D as an example).

Part II - Impacts From Past Dairy Practices

Part I of the recommended strategy deals with the abatement of the impacts of ongoing discharges of dairy wastes within the Chino Basin. Part II addresses the mitigation of the water quality impacts that past discharges of dairy wastes have caused within the Basin.

Water quality objectives for the Chino II and Chino III groundwater subbasins are being exceeded. Correction of this problem is imperative to protect the beneficial uses of those subbasins, and to prevent adverse impacts to the Santa Ana River and its downstream beneficial uses.

Responsibility for this water quality problem by dairies, other types of agriculture and other sources has been previously delineated in terms of the salt loads contributed to the Basin by each of these sources. Staff recommends that the responsibility for cleanup of the Chino Basin be assigned among these sources in
proportion to their salt load contributions. In this way, no one source would be asked to bear an unreasonable share of the cleanup burden; each source would be asked (or required) to assume only their fair share.

A number of different approaches could be utilized to define the of proportional responsibility for each source. One method would be to employ data regarding salt added to the Basin by each source from the time that dairies began operation in the Chino Basin. Basin Plan model data indicate that significant dairy land use within the Chino Basin began about 1958 and has increased steadily since that time. Data on salt added to the Basin by dairies and other land uses since 1958 were presented earlier in this report. Under this approach, the dairies would be responsible for approximately 60% of the cleanup which is ultimately determined necessary to correct water quality degradation in the Chino Basin (see Table 1, Section I). Note that this may not require the removal of all salts added by the dairy industry, or by others.

An alternative method of assigning proportional responsibility could be based on the salt contributions by each of the various sources since the assimilative capacity for additional salt input into the Basin was reached. Other methods using different types or subsets of salt load data (or other data) could also be utilized. The determination of the specific proportional responsibility to be assigned to dairies or any other source is
beyond the scope of this report and must await subsequent analysis and consideration. What is being proposed herein is the concept of proportional responsibility and the use of that concept to develop an equitable approach to water quality correction in the Chino Basin.

As stated earlier, Basin Plan modelling studies confirm that desalter operations will be an integral element of any Chino Basin cleanup strategy. The implementation of these desalters is already being pursued by other agencies within the Region. Other measures may be required. Staff believes that the costs of implementation and operation of any of these measures should be borne by all the sources of salt input, again, in proportion to their salt contributions.

It is recognized that the costs of cleanup in the Chino Basin will be large and may impose a significant burden on the dairy industry or other sources. A source of funding which the dairy industry, and other sources, are encouraged to explore is the formation of integrated financing districts, whereby liens would be placed on properties and collected when the properties are sold. The funds would then be used to fund cleanup projects. It has been noted that other agencies with water quality interests in the Chino Basin are already pursuing the implementation of some cleanup measures. Financial participation in these facilities may to some extent alleviate the costs to the dairy industry per se.
The Board could take two approaches to ensure that the dairy industry's portion of the cleanup program described above is achieved. One approach would be through enforcement orders (Cleanup and Abatement Orders) issued to each dairy operator. Alternatively, the Board could accept the voluntary commitment by the dairy industry to ensure that the necessary cleanup is accomplished. If said cleanup was not accomplished in this cooperative atmosphere, the Board could resort to appropriate enforcement. The choice of approach clearly rests with the Board, and with the dairy industry.

Part III - Surface Water Quality Impacts: Control of Urban Drainage in the Chino Agricultural Preserve

The third part of the recommended Chino Basin strategy addresses surface water drainage problems in the dairy area caused by runoff from upstream urban development. As discussed previously, this urban runoff creates additional difficulties for a number of dairy operators in complying with the manured water containment requirements contained in their waste discharge requirements. Recommendations are presented below to address this problem. It must be emphasized that these recommendations are directed to the counties and cities, rather than to the dairy industry.
A number of studies have been conducted to determine the best method of preventing urban stormwater runoff impacts in the Chino Basin dairy area. The most recent study, conducted with federal 205(j) planning funds, was completed in 1987 ("Chino Agricultural Preserve Drainage and Land Use Study"). The recommended solution to urban drainage problems was the construction of a trapezoidal earth swale at the northern boundary of the dairy area (roughly, at Riverside Avenue, between Campus Avenue and the Cucamonga Creek flood control channel (just west of Archibald Avenue)). This swale would intercept flows from upstream urban areas (cities of Ontario and Chino) and convey these flows to the Lower Cucamonga Spreading Grounds, adjacent to the Cucamonga Creek channel.

Funding for this measure was sought through the Agricultural Drainage Water Management Loan Program administered by the State Water Resources Control Board (State Board), but the project did not qualify. A new source of money has recently become available through the State Revolving Fund Loan Program. The State Board is proposing to set aside a minimum of $5 million of FFY 1991 State Revolving Fund monies for the purpose of issuing loans for eligible nonpoint source and/or estuary enhancement activities. Staff believes that the swale project will qualify as a nonpoint source project. The San Bernardino County Department of Transportation and Flood Control has recently applied to the State Board for a loan under this program.
To alleviate drainage problems in the dairy area and thereby reduce surface water quality problems which result from dairy waste inputs, the following measures need to be implemented:

1. Riverside Avenue interceptor swale - San Bernardino County and/or the cities of Ontario and Chino should pursue the funding and implementation of the interceptor swale project at Riverside Avenue.

2. Other drainage controls - Both San Bernardino and Riverside counties and the cities tributary to the dairy area should identify and implement a coordinated program of drainage controls necessary to supplement the interceptor swale and prevent drainage problems within the dairy area.

The Counties will be required to implement such best management practices (BMPs) as part of their upcoming NPDES stormwater permits.

**DAIRY OPERATIONS OUTSIDE THE CHINO BASIN**

This report has focused on dairy operations and water quality problems in the Chino Basin. Since the greatest concentration of dairies occurs in that area, this focus seems appropriate. But it must be remembered that there are established dairies elsewhere in
the Region, specifically, in the San Jacinto Basin. Many new dairies have been established in the San Jacinto Basin in recent years, and this trend appears to be continuing. To prevent the recurrence of the groundwater quality problem now confronting the Region in the Chino Basin, staff believes that an appropriate dairy waste management strategy for the San Jacinto Basin must be developed and implemented. The pattern of dairy land use, the quality of underlying groundwater, the availability of assimilative capacity in the San Jacinto groundwater subbasins should be considered in more detail before recommending a specific strategy. However, it is anticipated that many elements of the strategy recommended for the Chino Basin, particularly those parts which pertain to modifications of Waste Discharge Requirements, would apply also in the San Jacinto Basin. Staff recommends that the Board direct staff to prepare a dairy waste management strategy for the San Jacinto Basin.
APPENDIX A

Salt Loading Unit Factors:
Development and Application in the BPP

Since the early 1970’s, the Regional Board, in cooperation with
the Santa Ana Watershed Planning Agency (SAWPA) (now known as the
Santa Ana Watershed Project Authority), has used a water quality-
quantity mathematical model called the Basin Planning Procedure
(BPP) to estimate the water quality impacts of the dairy industry
and other types of land use on the waters of the basin. This
modeling procedure is capable of making projections of water
quality over time, based on assumptions of future patterns of land
use and associated waste loads. The modeling results are used to
identify optimal water and wastewater management plans, which are
then incorporated in the Basin Plan. The Plan is implemented
through the regulatory requirements of the Board and through the
participation of interested agencies, such as SAWPA, in
implementing programs and facilities found necessary to protect
water quality (e.g., the financing and construction of physical
facilities such as desalters).

Model Operations:  Unit Factors

The BPP calculates waste loads and water demands by multiplying
land use acreages in various categories by specific values, known
as unit factors. 23 different land uses are identified in the
model: six agricultural uses, two industrial uses, nine urban-
commercial uses inside the house, and six urban-commercial uses
outside the house (Table A-1). Each of these has been assigned a
unit factor value for 1) water demand, 2) consumptive use, and 3)
salt added to the groundwater (Table A-1: 1a, 1b, 1c, respectively).
The salt loading unit factor for a given land use represents the
mass loading of salt (expressed as tons/acre/year) that will be
transported through the unsaturated surface soil and enter into the
underlying groundwater as a result of that land use. An example
of the waste load calculation for dairies is as follows. Assuming
that there are 640 acres of dairy land and that the salt loading
unit factor for dairies is 2.4 tons/acre/year, the dairy waste load
would be:

640 acres x 2.4 tons salt/acre/year = 1536 tons salt/year

The modeling process starts with a baseline table of unit factors.
Table A-1 shows the values used in the development of the 1983
Basin Plan (Alternative III). Any of these unit factors can be
changed, if appropriate, at five year intervals through the
planning period being modeled. The unit factors can also vary
spatially, i.e., the unit factors for a specific land use type can
vary from one area of the Region to another. These changes in unit
factors can reflect changes in waste management practices and

A-1
<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>1A Water Demand Unit Factors</th>
<th>Unit Factor</th>
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<td></td>
<td></td>
<td>Acre Feet/Acre/Year (or as noted)</td>
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<tr>
<td>Agriculture</td>
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<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
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<td>2.8</td>
</tr>
<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td></td>
<td>2.6</td>
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<tr>
<td>3. Irrigated Orchards</td>
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<td>0.6</td>
</tr>
<tr>
<td>4. Vineyards</td>
<td></td>
<td>0.84</td>
</tr>
<tr>
<td>5. Dairies, Feedlots, Poultry</td>
<td></td>
<td>0.0</td>
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<tr>
<td>6. Other Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td>1.35</td>
</tr>
<tr>
<td>7. Light Industry</td>
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<td>0.0</td>
</tr>
<tr>
<td>8. Heavy Industry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban-Commercial (Inside Use)</td>
<td></td>
<td>90.0 gpcd</td>
</tr>
<tr>
<td>9. Single Family Residential</td>
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<td>95.0 gpcd</td>
</tr>
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<td>10. Multiple Family Residential</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>11. Regional &amp; General Commercial</td>
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<td>1.0</td>
</tr>
<tr>
<td>12. Commercial Strip</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>13. Neighborhood Shopping Centers</td>
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<td>80.0 gpcd</td>
</tr>
<tr>
<td>14. Public &amp; Institutional Facilities</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>15. Schools</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>16. Transportation/Communication (Airports)</td>
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<td>0.1</td>
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<td>17. Military</td>
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<td></td>
</tr>
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<td>Urban-Commercial (Outside Use)</td>
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<td>90.0 gpcd</td>
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<tr>
<td>19. Multiple Family Residential</td>
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<td>0.4</td>
</tr>
<tr>
<td>20. Public &amp; Institutional Facilities</td>
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<td>0.6</td>
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<td>0.1</td>
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<tr>
<td>23. Transportation/Communication</td>
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# Table A-1 (cont.)

## 18 Consumptive Use Unit Factors By Land Use Category

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<thead>
<tr>
<th>Agriculture</th>
<th>Unit Factor Percent Consumed</th>
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<tbody>
<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
<td>0.50</td>
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<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td>0.60</td>
</tr>
<tr>
<td>3. Irrigated Orchards</td>
<td>0.70</td>
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<td>4. Vineyards</td>
<td>0.65</td>
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<td>5. Dairies, Feedlots, Poultry</td>
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<td>6. Other Agriculture</td>
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<table>
<thead>
<tr>
<th>Industry</th>
<th>Unit Factor Percent Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Light Industry</td>
<td>0.50</td>
</tr>
<tr>
<td>8. Heavy Industry</td>
<td>0.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban-Commercial (Inside Use)</th>
<th>Unit Factor Percent Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Single Family Residential</td>
<td>0.0</td>
</tr>
<tr>
<td>10. Multiple Family Residential</td>
<td>0.0</td>
</tr>
<tr>
<td>11. Regional &amp; General Commercial</td>
<td>0.333</td>
</tr>
<tr>
<td>12. Commercial Strip</td>
<td>0.2</td>
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<tr>
<td>13. Neighborhood Shopping Centers</td>
<td>0.333</td>
</tr>
<tr>
<td>14. Public &amp; Institutional Facilities</td>
<td>0.0</td>
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<td>15. Schools</td>
<td>0.0</td>
</tr>
<tr>
<td>16. Transportation/Communication (Airports)</td>
<td>0.0</td>
</tr>
<tr>
<td>17. Military</td>
<td>0.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban-Commercial (Outside Use)</th>
<th>Unit Factor Percent Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. Single Family Residential</td>
<td>0.714</td>
</tr>
<tr>
<td>19. Multiple Family Residential</td>
<td>0.714</td>
</tr>
<tr>
<td>20. Public &amp; Institutional Facilities</td>
<td>0.667</td>
</tr>
<tr>
<td>21. Schools</td>
<td>0.667</td>
</tr>
<tr>
<td>22. Irrigated Greenspace</td>
<td>0.692</td>
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<tr>
<td>23. Transportation/Communication</td>
<td>0.600</td>
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## 1C Salt Added Unit Factors By Land Use Category

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Unit Factor Tons/Acre/Year (or as noted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Irrigated Pasture &amp; Field Crops</td>
<td>0.234</td>
</tr>
<tr>
<td>2. Irrigated Row &amp; Truck Crops</td>
<td>0.296</td>
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<tr>
<td>3. Irrigated Orchards</td>
<td>0.312</td>
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<td>4. Vineyards</td>
<td>0.142</td>
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<td>5. Dairies, Feedlots, Poultry</td>
<td>2.38</td>
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<td>6. Other Agriculture</td>
<td>0.0</td>
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### Table A-1 (cont.)

**1C Salt Added Unit Factors**

<table>
<thead>
<tr>
<th>Industry</th>
<th>T/A/Y (returnwater)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Light Industry</td>
<td>0.408</td>
</tr>
<tr>
<td>8. Heavy Industry</td>
<td>0.408</td>
</tr>
</tbody>
</table>

#### Urban-Commercial (Inside Use)

<table>
<thead>
<tr>
<th>Industry</th>
<th>T/A/Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Single Family Residential</td>
<td>0.34</td>
</tr>
<tr>
<td>10. Multiple Family Residential</td>
<td>0.34</td>
</tr>
<tr>
<td>11. Regional &amp; General Commercial</td>
<td>0.34</td>
</tr>
<tr>
<td>12. Commercial Strip</td>
<td>0.34</td>
</tr>
<tr>
<td>13. Neighborhood Shopping Centers</td>
<td>0.34</td>
</tr>
<tr>
<td>14. Public &amp; Institutional</td>
<td>0.34</td>
</tr>
<tr>
<td>15. Schools</td>
<td>0.34</td>
</tr>
<tr>
<td>16. Transportation/Communication (Airports)</td>
<td>0.34</td>
</tr>
<tr>
<td>17. Military</td>
<td>0.34</td>
</tr>
</tbody>
</table>

#### Urban-Commercial (Outside Use)

<table>
<thead>
<tr>
<th>Industry</th>
<th>T/A/Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. Single Family Residential</td>
<td>0.147</td>
</tr>
<tr>
<td>19. Multiple Family Residential</td>
<td>0.147</td>
</tr>
<tr>
<td>20. Public &amp; Institutional Facilities</td>
<td>0.173</td>
</tr>
<tr>
<td>21. Schools</td>
<td>0.173</td>
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<tr>
<td>22. Irrigated Greenspace</td>
<td>0.657</td>
</tr>
<tr>
<td>23. Transportation/Communication</td>
<td>0.275</td>
</tr>
</tbody>
</table>
requirements. For example, a more restrictive manure disposal requirement (i.e., less than 3 tons/acre/year on disposal land allowed) would translate into a lower salt unit factor for dairy operations (provided that there is compliance). Thus, by adjusting the unit factors assigned, the effectiveness of both present and proposed regulatory strategies (e.g., manure disposal requirements) in protecting water quality can be tested. In this way, the BPP serves as an excellent regulatory tool.

Most of these unit factor values were derived initially in early work by the Department of Water Resources (DWR) and consultants to SAWPA (as the Board’s Basin Plan contractor). Some have undergone significant change over time. The evolution of the dairy salt loading unit factor is a case in point; a concise review of this evolutionary process is helpful in understanding the Board’s present dairy regulatory program and the use of the BPP to evaluate possible changes in dairy waste management strategy.

**Dairy Salt Loading Unit Factors**

As stated in the main body of this report, there have been numerous BPP runs made over the past two decades to evaluate the water quality effects of the dairy operations in the Chino Basin. Each time these runs have been conducted, the dairy salt loading unit factor to be used in the model has been considered. Most recently, the dairy salt unit factor (and those for other land uses) was considered in conjunction with the modeling studies being conducted as a part of the ongoing watershed-wide nitrogen study. A summary of the dairy salt loading unit factors which have been or are being employed in BPP modeling efforts to date is provided in Table A-2, below.
<table>
<thead>
<tr>
<th>Year</th>
<th>TDS</th>
<th>Nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975 Basin Plan</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>1983 Basin Plan</td>
<td>3.38</td>
<td></td>
</tr>
<tr>
<td>(Alternative I)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983 Basin Plan</td>
<td>2.97</td>
<td></td>
</tr>
<tr>
<td>(Alternative II)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983 Basin Plan</td>
<td>2.38</td>
<td></td>
</tr>
<tr>
<td>(Alternative III)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Recommended Plan)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988 MWD Chino Basin Conjunctive Use Study</td>
<td>5.94</td>
<td>1.205</td>
</tr>
<tr>
<td>1988 Basin Plan Base Plan</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>1988 Basin Plan Alternative III</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>1989 Nitrogen Study</td>
<td>2.54</td>
<td>0.776</td>
</tr>
</tbody>
</table>

| (2.54 (historic)) |

Note: BFP calibrated only for TDS through 1988. Model calibration for nitrogen and incorporation of nitrate unit factors are part of 1989 watershed-wide nitrogen study (James M. Montgomery Engineers for SAWPA/SARDA, et al).
The differences among the unit factors shown in Table A-2 are related to actual or assumed dairy waste management practices and the amount of salt thereby removed from the dairy area. The 1975 Basin Plan unit factor was based on the assumption that all wash water would be removed from the dairy area and that all but 10% of the manure generated would be exported (i.e., 90% removal of all dairy salt). The other unit factors reflect different information regarding wash water and manure disposal. As discussed in the main body of this report, wash water removal through sewerage (or any other means) has not been accomplished. Therefore, the unit factors used from 1983 and later include the salt associated with wash water disposal on pasture and cropland in the dairy area. These later unit factors also reflect different assumptions or estimates (based on dairy annual reports) of the amount of manure removed from the area. For the 1988 Basin Plan update baseline run (Base Plan), for example, information from the 1987 dairy annual reports indicated that only 50% of the manure generated in the dairy area was removed. This translated to a salt loading factor of 2.4 tons/acre/year (Table A-3). The water quality effects of a proposed alternative plan were also evaluated (Alternative III (1988)); the dairy salt unit factor assumed therein for planning purposes was 1.75 Tons/Ac/Year. Clearly, this lower unit factor implies that more manure was removed from the area. Note that greater manure removal could theoretically be achieved through greater compliance with the Board's existing manure disposal requirement (3 Tons/Ac/Year) or through the adoption of (and full compliance with) a more stringent manure disposal requirement. This illustrates how the BPP can be used to assess the water quality impacts of changes in the nature and/or implementation of the Board's requirements.
Table A-3

1988 Base Plan Dairy Salt Unit Factor

Calculation of 1988 Base Plan (Upper Santa Ana Basin Plan Update) dairy salt unit factor:

a. 4.061 tons salt/acre/year = total unregulated salt loading to groundwater from dairy operations (Webb, 1974, Table 12; 15 cows/acre assumed)

b. 50% removal of dairy manure (see calculation below):
   \[ 4.061 \times 50\% = 2.0305 \text{ tons salt/acre/year} \]

c. no wash water removal; wash water applied to dairy land; wash water contains approx. 10% of the total dairy waste salt load (Webb, 1974):
   \[ 4.061 \times 10\% = 0.4061 \]

d. total dairy salt load to groundwater:
   \[ 2.0305 + 0.4061 = 2.436 \text{ (2.4) tons/acre/year} \]

Calculation of % manure removal: (data from annual dairy compliance report to the Regional Board (4-10-87))

Manure produced: \(- 448,500\) tons (dry weight)

Manure reported hauled: \(- 362,000\) tons

fate of manure hauled is unknown: assume that 1/2 of 362,000 hauled is removed from Basin = \(- 181,000\) tons

manure reported used on cropland: \(- 57,400\) tons

\[
\begin{array}{c}
448,500 \\
- 181,000 \\
267,500 \\
- 57,400 \\
210,100 \text{ tons}
\end{array}
\]

\[ 210,100 / 448,500 = 0.47 \text{ or } -50\% \]

Note: For the 1988 year (March 10, 1989 report) the manure removal value came to about 55%.
A point which was made earlier in this report should be reemphasized here. That is that these salt loading unit factors for dairy operations are estimates. The information which is available concerning manure removal from the dairy area comes almost exclusively from the dairy annual reports submitted by the dairy operators. It must be emphasized that this information is neither detailed nor necessarily accurate and is not adequate to provide a true picture of the actual fate of all the manure generated. An improved manure tracking system is definitely necessary for this purpose. Further, we do not consider our understanding of the fate of salts applied to surface soils via dairy waste disposal to be definitive. A comprehensive groundwater monitoring program is necessary to provide actual data on the impacts of dairy operations. The information presented by Webb (1974) regarding salt loading rates from dairy operations to groundwater is widely accepted as the best available at the present time. But it is possible that monitoring data and more refined modeling techniques would suggest that modifications of the salt unit factors, for dairies and other types of land use, would be appropriate.

**Nondairy Agricultural Salt Unit Factors**

Nondairy agricultural salt loading unit factors were developed by in the early 1970’s for use in the BPP (WRE, 1970). Since precise records of crop types and fertilizers for agricultural lands within the Region did not exist, unit salt loading factors were estimated by formulating a regional fertilizer mix on a weighted average basis, with common fertilizers used within the Region. This mix is presented below:

<table>
<thead>
<tr>
<th>Fertilizer Type</th>
<th>Relative Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea, Anhydrous Ammonia</td>
<td>60%</td>
</tr>
<tr>
<td>Calcium Nitrate</td>
<td>10%</td>
</tr>
<tr>
<td>Ammonium Sulfate</td>
<td>10%</td>
</tr>
<tr>
<td>Dairy Manure</td>
<td>20%</td>
</tr>
</tbody>
</table>

*(WRE, 1970)*

**Table A-4**

**Common Fertilizers and Relative Use**

A-9
A fertilizer mix weighted by relative use consists of the following weights of anions and cation per 100 lbs. of total nitrogen:

Table A-5

<table>
<thead>
<tr>
<th>Cations</th>
<th>Weight (lbs.)</th>
<th>Anions</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>Cl</td>
<td>8</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>SO₄</td>
<td>45</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>NO₃</td>
<td>359</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>PO₄</td>
<td>14</td>
</tr>
</tbody>
</table>

Note that direct conversion of 100 lbs. of nitrogen to nitrate (NO₃) is 443 lbs. However, Table A-5 lists only 359 lbs. of nitrate for every 100 lbs. of total nitrogen. The reduction from 443 to 359 lbs. is attributable to the assumed volatilization of nitrogen in the form of ammonia and the fixation (uptake) of nitrogen by soil microorganisms (WRE, 1970).

When the regional fertilizer mix is applied to the agricultural soil, crop uptake, volatilization, soil microorganism fixation, and a number of geochemical reactions occur which effectively reduce the amount of salt contained in the fertilizer from leaching to the underlying ground water aquifer. Volatilization and fixation of nitrogen have already been taken into account. Crops will utilize nitrate (NO₃) and ammonium (NH₄), potassium (K), and phosphate (PO₄). Cations will adsorb to and desorb from negatively charged soil particles which constitutes a process known as ion exchange. Available phosphorous may also react with calcium to form a relatively insoluble product, calcium phosphate, which is immobile in the soil. Calcium (Ca) and magnesium (Mg) will react with bicarbonate (HCO₃) in the irrigation water to also form relatively insoluble salts. The anions chloride (Cl), sulfate (SO₄), and nitrate (NO₃) will move readily with the soil water and associate with the most predominant cation, which is also transported through the soil. Since the soils in the Chino Basin dairy area are reported to be rich in calcium, this cation was assumed by WRE (1970) to be transported with the mobile nitrate or sulfate. However, sodium was assumed to be associated with the chloride moving through the soil, which does not result in a significant difference in the total salt unit load factor.
By applying the regional fertilizer mix to similar crop types at application rates developed through consultation with local farm advisors, the salt contribution to ground water was estimated by WRE (1970). As an example of the detailed computations required for the formulation of each loading factor, the specific case for irrigated citrus was considered by staff, using WRE’s methodology.

Table A-6

Development of the Salt Loading Factor for Irrigated Citrus

<table>
<thead>
<tr>
<th>Ion</th>
<th>Weight Per 100 lbs N (lbs.)</th>
<th>Weight Per 100 lbs N (lbs.)</th>
<th>Crop Uptake (lbs.)</th>
<th>Leaching (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>126</td>
<td>202</td>
<td>--</td>
<td>124 [Ca(NO₃)₂]</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
<td>23</td>
<td>--</td>
<td>32 [Ca(SO₄)₂]</td>
</tr>
<tr>
<td>K</td>
<td>23</td>
<td>37</td>
<td>37</td>
<td>--</td>
</tr>
<tr>
<td>Na</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>8 [NaCl]</td>
</tr>
<tr>
<td>Cl</td>
<td>8</td>
<td>13</td>
<td>--</td>
<td>13</td>
</tr>
<tr>
<td>SO₄</td>
<td>45</td>
<td>72</td>
<td>--</td>
<td>72</td>
</tr>
<tr>
<td>NO₃</td>
<td>359</td>
<td>574</td>
<td>186</td>
<td>388</td>
</tr>
<tr>
<td>PO₄</td>
<td>14</td>
<td>22</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total Salt</strong></td>
<td>627 lbs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.318 tons)</td>
</tr>
</tbody>
</table>

Thus, 0.318 tons of salt/acre/year was estimated by staff to be contributed to the ground water from the application of the regional fertilizer mix from citrus agriculture. This value is reasonably consistent with the unit factor reported by WRE (1970) of 0.312. The reason for the difference is unknown, but might be the result of round off error or slight differences in the fertilizer application rate or crop uptake rates, which were reported by Hassan (1969).
The nondairy agricultural salt unit factors developed by WRE have been used in BPP work with only minor modifications since the early 1970's. However, some of these unit factors were recently updated through the calibration of the BPP in work performed by James M. Montgomery Engineers (JMM, 1989) as part of the watershed-wide nitrogen study. Unit factors for nitrate as well as TDS have also been developed by JMM for these nondairy agricultural land uses. An historical listing of the unit factors for nondairy agricultural land use is shown below:

Table A-7

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated Pasture + Field Crops</td>
<td>0.234</td>
<td>0.234</td>
<td>0.23</td>
</tr>
<tr>
<td>Irrigated Row + Truck Crops</td>
<td>0.296</td>
<td>0.296</td>
<td>--</td>
</tr>
<tr>
<td>Irrigated Orchards</td>
<td>0.312</td>
<td>0.312</td>
<td>0.21</td>
</tr>
<tr>
<td>Vineyards</td>
<td>0.142</td>
<td>0.142</td>
<td>0.142</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Non Irrigated Hay and Pasteur, Field Crops</td>
<td>0.0</td>
<td>--</td>
<td>0.23</td>
</tr>
</tbody>
</table>

*Model calibrated only for TDS; no nitrate unit factors.*

Model Evaluation of Salt Leaching from Fertilizers

Nondairy agricultural salt unit factors have been considered even more recently by Regional Board staff (as a part of the preparation of this report). In order to evaluate the amount of salt leaching from various fertilizers to the ground water, Regional Board staff employed a computer model developed by the U.S. Salinity Laboratory. The model simulates the steady-state transport of specific ions which comprise the salts in fertilizers. Essentially the same methodology that was used by UCCD (1973) was employed.
during this analysis. These comparisons were made to provide general insight into the relative amounts of salt contained in fertilizer that leach beyond the plant root zone and enter the underlying ground water. Simulations which consider all factors which will effect salt transport in soil, such as, soil composition and stratigraphy or the addition of soil amendments were not considered in this evaluation.

The computer model developed by the Salinity Laboratory is commonly used to evaluate the suitability of water for irrigation use. The model simulates the concentration (meq/l) of predominant anions and cations in the soil water within the plant root zone. Not all of the salt that is applied to land from fertilizer or irrigation water will leach to the ground water table. Plants will take up significant amounts of nitrogen and to a much smaller degree some of the other salts. Some of the other salts in the soil water will also precipitate to form relatively insoluble compounds that remain in the soil. Thus, only about one-half of the salts originally applied to the soil will actually be transported to the ground water, but the actual amount depends on factors considered in the model, which include the irrigation leaching fraction, the partial pressure of CO₂, and the specific ion characteristics of the irrigation water and applied fertilizer, and the ionic strength of the soil water solution.

The Salinity Laboratory model does not account for plant uptake or the presence of phosphate in the applied water. Thus, a computer program (prepwats.m) was developed by staff to consider these factors before the Salinity Laboratory model (watsuit.for) could be employed. Staff used the same rationale employed by UCCC (1973). A second computer program (convwats.m) was also formulated by staff to convert the results produced by the Salinity Laboratory model into unit loading rates (tons/acre/year) commonly used in the Santa Ana Basin computer model. All of the computer programs employed for these evaluations are included in this Appendix.

The results of these simulations are described in Section III-D.

1(Presented in Tables 4-10 and 4-11 of this staff report).
APPENDIX B

Calculation of the 1 ton(dry)/acre/year Manure Disposal Requirement

Using data generated by UCCC (1973a) and UCCC (1973b), and reported by Webb (1974), Regional Board staff developed a regression curve for the relationship between the amount of salt applied to agricultural land in manure and the mass of salt which will migrate to groundwater.

The form of the regression curve is:

\[ y = ax^b \]

where:

\[ y = \text{the mass of salt per acre transported to the ground water.} \]
\[ x = \text{the mass of salt per acre applied to the agricultural land in the manure.} \]
\[ a = 0.34988 \]
\[ b = 1.06473 \]

The regression coefficient for this curve fit was 0.99933, where a value of 1.00 represents a perfect fit of the regression curve with the data.

The calculations substantiating the 3 ton dry manure/acre/year application limit uses this regression curve. These calculations are presented below:

Allowable amount of salt that may be applied:

\[ (0.30/0.34988)^{1/1.0647} = 0.86 \text{ tons of salt/acre/year} \]

Allowable dry weight of manure that is equivalent to the 0.86 tons/acre loading rate is:

\[ \frac{0.86 \text{ tons salt}}{acre} \times \frac{1 \text{ ton manure}}{0.2873 \text{ tons salt/acre year}} = 3.01 \text{ tons dry manure/acre year} \]
Memorandum

September 26, 1989

California Regional Water Quality Control Board
Santa Ana Region
6809 Indiana Avenue, Suite 200
Riverside, CA 92506
Attention: Joanne Schneider
Environmental Program Manager

From:
Department of Water Resources
Los Angeles, CA 90055

Subject:
Order No. 89-131, Waste Discharge Requirements for J. B. Aquerre, dba J. B.'s Calves, Chino, San Bernardino County

We appreciate the opportunity to review and comment on the subject discharge.

In support of your requirements to protect the local water resources we recommend that the discharger, J.B.’s Calves, be required to submit the following to your Executive Officer for evaluation and approval:

1. A site specific engineering plan to retain all dairy waste water within the dairy including the precipitation on and drainage through manured areas which can result from rain in a 24-hour period in a 25 year, 24-hour storm; and,

2. A site specific engineering plan to divert surface flow to prevent inundation of the disposal and manured areas by runoff that could result from a 24-hour, 100 year frequency storm.

And we recommend that this order stipulate that manure removed from the dairy for offsite disposal be hauled only to sites previously approved by the Board to accept dairy waste.

We also recommend that the underlined be added to requirement No. 3 in the Reporting Program.

3. All reports shall be signed and submitted by a principal executive officer or equivalent or his/her authorized representative under penalty of perjury.

If you have any questions concerning our comments, you may wish to contact Harry Iwanaga of my staff at (213) 620-4836.

Harry Iwanaga

Ahmed A. Bassan, Ph.D., Chief
Resources Inventory Branch
Appendix E

SAMPLE MANURE TRACKING MANIFEST

This form must be completed for each day and each location where manure is transported. All information provided on this form is submitted under penalty of perjury.

Operator's Name: ________________________________

Facility Name: ________________________________

Facility Address: ________________________________

Mailing Address: ________________________________

Hauler's Name: ________________________________

Amount Hauled: _______ Tons        Date Hauled: _______

Hauled to: (address, Township/Range coordinates, or nearest major cross street)

________________________________________________

Hauler's Signature: ________________________________

Date: _________________________________________

Owner/Responsible Party of Final Destination Point: (print or type)

________________________________________________

Owner's/ R.P.'s Signature: ________________________________

Date: ________________________________

This form must be returned to the animal confinement facility operator upon completion.

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APPENDIX F

ITEMS THAT SHOULD BE INCLUDED IN ENGINEERED WASTE MANAGEMENT PLANS

The following information shall be submitted as an attachment to Reports of Waste Discharge for all animal confinement facilities. The waste management plan shall be developed by a registered professional engineer, a member of the West End Resource Conservation District, a member of the Soil Conservation Service, or other qualified persons, as approved by the Executive Officer.

SITE PLAN REQUIREMENTS

The Site Plan shall include:

1. Assessor parcel number(s), address and/or legal description of the facility.

2. Name, address, and telephone number of the owner and operator of the proposed facility.

3. The total gross acreage of property, showing all existing and/or proposed facilities [including buildings, storage areas, berms, holding ponds, well sites, pumping facilities, storm water conveyance facilities, culverts, drainage easements, disposal area(s), cropland (whether farmed by the owner/operator or another party), etc]. Include the overall dimensions, north arrow, date the plan was developed, and scale. The site plan shall be submitted at an appropriate scale that shows sufficient detail of the proposed facility and all site operations including all disposal areas and wastewater containment structures. A recommended scale would be 1" = 50’. The plan should be drawn on standard 17 X 36 blue print format.

4. Containment facilities shall be designed to retain on the property all dairy washwater and stormwater runoff due to precipitation on and drainage through manured areas which results from any one storm event up to and including a 25-year, 24-hour storm event. All manured areas shall be protected from inundation resulting from a 100 year frequency storm. The site plan shall show all facilities necessary for containment and management of all storm water flows onsite as well as the interception
and conveyance of any offsite storm water flows through the proposed site.

7. The site plan shall show the size, elevations, and location of all facilities proposed for containment of wastewater and storm water flows on the site (berms, holding ponds, upstream diversion structures, etc.). Cutaway details of these structures shall be shown.

8. A description of all of the existing and proposed disposal areas for washwater shall be provided. This description should include all disposal areas and/or cropland designated to receive dairy wastes.

DESIGN CALCULATIONS

Design calculations shall include:

1. The volume of dairy washwater generated.

2. A determination of the amount of rainfall that will result from a 24-hour, 25-year storm event.

3. The total amount of water that will need to be contained onsite (washwater + stormwater).

4. The volume of upstream flows that will need to be diverted from manured areas from 100 year storm events (a description of the methodology used to determine the volume of the 100 year storm event should also be included).

5. Percolation rates used in determining wastewater management.

CONSTRUCTION SPECIFICATIONS

Construction Specifications shall include:

1. The construction material to be used and the method of compaction of all berms and/or other containment structures.

OPERATIONS PLAN

The Operations Plan shall include:

1. A proposed rodent control program.
2. A proposed pond management program (this program should be directed to providing maximum capacity prior to winter storms, periodic dredging, etc.)

3. A proposed wastewater distribution program (rotation of fields/areas receiving wastewater, etc.)
REFERENCES


California Regional Water Quality Control Board, Santa Ana Region, 1975, "Water Quality Control Plan, Santa Ana River Basin (8)".

California Regional Water Quality Control Board, Santa Ana Region, 1983, "Water Quality Control Plan Report, Santa Ana River Basin (8)".


Meyer, J. L., R. S. Rauschkolb, and E. Olson, (no date) Published?, "Dairy Manure Utilization and Field Application Rates.

G-1

001433
Pratt, P. F., 1984a, "Nitrogen use and nitrate leaching in irrigated agriculture", in Nitrogen in Crop Production, Madison, WI.


Santa Ana Watershed Project Authority, 1990, "Chino Basin Desalter Feasibility Study", Camp Dresser & McKee


State Water Resources Control Board, 1975, "Water Quality Control Plan Report, Santa Ana River Basin (5), Regional Water Quality Control Board Santa Ana Region (6)."


University of California Water Quality Task Force, Committee of Consultants (UCCC), 1973a, "Supporting data, salt and nitrate excreted by various livestock", March 7 memorandum.

APPENDIX C
Groundwater Quality

The groundwater basin in the Kern County portion of the San Joaquin Valley is a basin of interior drainage. It has no appreciable surface or subsurface outflow, except in extremely wet years (Kern County Water Agency, 1998). Salts (generally measured as total dissolved solids [TDS]) are introduced into the basin with imported water supplies. Although the water may leave the basin by evaporation or evapotranspiration, the majority of the salts stay behind, potentially leading to a build-up of salt in the soil and groundwater. Excessive salt loading can result in a degraded water supply, particularly if concentrations exceed the Secondary Drinking Water standard of 500 mg/L. Salt loading of managed groundwater basins is an important issue throughout the central San Joaquin Valley.

Manufactured fertilizers and manure generated by livestock contain salts and nitrogen (nitrogen is essential for plant growth). Salts leaching from manufactured fertilizers and manures contribute to the potential salt loading problem in the groundwater basin. Dairy manure tends to contain more salts than manufactured fertilizers (Table 4.3-1 shows examples of salt contents in fertilizers) and, therefore, groundwater underlying agricultural fields fertilized with manure may be more susceptible to salt loading increases.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Regional Mix</th>
<th>15:15:15 Blend</th>
<th>Dairy Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (Ca)</td>
<td>126</td>
<td>0</td>
<td>147</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>4</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>5</td>
<td>0</td>
<td>292</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>23</td>
<td>80</td>
<td>28</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>8</td>
<td>73</td>
<td>82</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>45</td>
<td>173</td>
<td>123</td>
</tr>
<tr>
<td>Phosphate (HPO₄)</td>
<td>14</td>
<td>143</td>
<td>188</td>
</tr>
<tr>
<td>Nitrate (NO₃)</td>
<td>399</td>
<td>443</td>
<td>443</td>
</tr>
<tr>
<td>Total salts</td>
<td>584</td>
<td>912</td>
<td>1,370</td>
</tr>
<tr>
<td>Non-nitrogen salts</td>
<td>225</td>
<td>469</td>
<td>927</td>
</tr>
<tr>
<td>Non-nitrogen/total salts ratio</td>
<td>39%</td>
<td>52%</td>
<td>68%</td>
</tr>
</tbody>
</table>


For the purpose of developing a salt loading unit factor for agricultural uses other than dairies, a regional fertilizer mix was formulated on a weighted basis using fertilizers commonly used within the region.

Blend consisting of 40% ammonia sulfate, 33% diammonium phosphate, 25% murate of potash, and 2.5% urea.

Excess nitrogen (in its nitrate form) in groundwater is a significant problem in some agricultural areas. Nitrates have been associated with several environmental problems in surface water, including eutrophication and altering the productivity of natural ecosystems. The effect of nitrates on human health is also a concern. High concentrations of nitrates

Kern County
3 September 1999
99217bba.hyd.wpd-9/3/99

BORBA DAIRIES PROJECT
4.3 Water Resources

4.3-9

001437

2093
(PSP), adopted by Kern County in 1994 to allow development of a “new town” in that portion of the project site. The additional 434 acres in the northwestern portion of the project site was not included within the PSP area. Adoption of the PSP provided the opportunity to develop a wide range of urban uses within the PSP area, including residential, commercial, industrial, and public facility uses. Although the zoning change to modify zoning from “Exclusive Agriculture” to “Specific Planning District” to implement the Specific Plan was referred back to the Kern County Planning Department for consideration, it was not implemented. Therefore, the area of the proposed project remains zoned as “Exclusive Agriculture.” Although dairies, such as proposed by the project, are a permissible use within “Exclusive Agriculture” zones, the Kern County Zoning Ordinance requires minimum buffers for dairies from specific uses, such as communities and special uses, to minimize the potential for land use conflicts. The location of Dairy 2 of the proposed project does not meet the minimum buffer requirements from the community of Old River or from Lakeside Union School and, therefore, is subject to a requirement for a Conditional Use Permit (CUP).

The location of Dairy 1 meets the minimum buffer requirements upon approval of the project. Following review of grading plans and approval of the project design by the Kern County Mosquito Abatement District, a grading authorization was issued in November 1999 for construction of Dairy 1. Grading of that site was begun in January 1999 but is not yet complete and has been suspended pending completion of the environmental review and approval process. The County has required preparation of either a development agreement or a CUP to ensure that any mitigation measures required for the project would be applied to both proposed dairies.

3.2.1 Proposed Facilities

The proposed project is a development of a new dairy operation in west-central Kern County (Figure 3-1). The project would consist of two dairies (Dairy 1 and Dairy 2) constructed on the project site, which encompasses 4,677 acres (Figure 3-2). Dairy 1 would be developed in the northern half of Section 10; Dairy 2 (George Borba) would be constructed in the southern half of Section 2 and northern portion of Section 11. Each dairy operation would cover approximately 341 acres; the remainder of the site would be devoted to agricultural crop production. The dairies would each support approximately 7,200 dairy cows and related stock; the related stock includes 3,264 dry cows and bred heifers, 1,092 heifers, and 2,730 calves. Each dairy would, therefore, support approximately 14,286 cattle for a total of 28,572 cattle at the project site. The applicants have proposed two dairies, operated by two separate entities, that would share common access to improve the operating efficiency of each dairy facility and to “streamline” the permitting and environmental review process.

The proposed dairy herds were developed on the basis of estimated animal waste generation and the amount of land on the project site that is available for waste application. Allowable waste loading rates are calculated on the basis of “animal units,” a normalizing factor that accounts for animal size and waste production (see Appendix C). A 1,000-pound mature milking cow is the standard unit (1.0 animal unit); smaller, non-lactating
### Table 6-6: Plant nutrient uptake by specified crop and removed in the harvested part of the crop (Kilmer 1982; Morrison 1956; Sanchez 1976; USDA 1985)

| Crop      | Dry wt. lb/bu | Typical yield/acre plant part | N   | P   | K   | Ca  | Mg  | S   | Cu  | Mn  | Zn  |
|-----------|---------------|-------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Grain crops** |               |                               |     |     |     |     |     |     |     |     |     |     |
| Barley    | 48            | 50 bu                         | 1.82| 0.34| 0.43| 0.05| 0.10| 0.16| 0.0016| 0.0016| 0.0031|
|           |               | 1 T. straw                    | 0.75| 0.11| 1.25| 0.40| 0.10| 0.20| 0.0005| 0.0160| 0.0025|
| Buckwheat | 48            | 30 bu                         | 1.65| 0.31| 0.45| 0.09|     |     | 0.0009| 0.0034|     |
|           |               | 0.5 T. straw                  | 0.78| 0.05| 2.26| 1.40|     |     | 0.11|     |     |
| Corn      | 56            | 120 bu                        | 1.61| 0.28| 0.40| 0.02| 0.10| 0.12| 0.0007| 0.0011| 0.0018|
|           |               | 4.5 T. stover                 | 1.11| 0.20| 1.34| 0.29| 0.22| 0.16| 0.0005| 0.0164| 0.0033|
| Oats      | 32            | 80 bu                         | 1.95| 0.34| 0.49| 0.08| 0.12| 0.20| 0.0012| 0.0047| 0.0020|
|           |               | 2 T. straw                    | 0.63| 0.16| 1.66| 0.20| 0.20| 0.23| 0.0008| 0.0030| 0.0072|
| Rice      | 45            | 5,500 lb                      | 1.39| 0.24| 0.23| 0.08| 0.11| 0.08| 0.0030| 0.0022| 0.0019|
|           |               | 2.5 T. straw                  | 0.60| 0.09| 1.16| 0.18| 0.10| 0.31|     |     |     |
| Rye       | 56            | 30 bu                         | 2.08| 0.26| 0.49| 0.12| 0.18| 0.42| 0.0012| 0.0131| 0.0018|
|           |               | 1.5 T. straw                  | 0.50| 0.12| 0.69| 0.27| 0.07| 0.10| 0.0000| 0.0047| 0.0023|
| Sorghum   | 56            | 60 bu                         | 1.67| 0.36| 0.42| 0.13| 0.17| 0.17| 0.0003| 0.0013| 0.0013|
|           |               | 3 T. stover                   | 1.08| 0.15| 1.31| 0.48| 0.30| 0.13| 0.0016|     |     |
| Wheat     | 60            | 40 bu                         | 2.08| 0.62| 0.52| 0.04| 0.25| 0.13| 0.0013| 0.0038| 0.0058|
|           |               | 1.5 T. straw                  | 0.67| 0.07| 0.97| 0.20| 0.10| 0.17| 0.0003| 0.0053| 0.0017|

<p>| <strong>Oil crops</strong> |               | % of the dry harvested material |     |     |     |     |     |     |     |     |     |     |
| Flax       | 56            | 15 bu                         | 4.09| 0.55| 0.84| 0.23| 0.43| 0.25| 0.0061|     |     |
|            |               | 1.75 T. straw                | 1.24| 0.11| 1.75| 0.72| 0.31| 0.27|     |     |     |
| Oil palm   |               | 22,000 lb                    | 1.13| 0.26| 0.16| 0.19| 0.09| 0.0043| 0.0225|     |     |
|            |               | 5 T. fronds &amp; stems          | 1.07| 0.49| 1.69|     |     |     | 0.36|     |     |
| Peanuts    | 22-30         | 2,800 lb                     | 3.60| 0.17| 0.50| 0.04| 0.12| 0.24| 0.0008| 0.0040|     |
|            |               | 2.2 T. vines                 | 2.33| 0.24| 1.75| 1.00| 0.38| 0.36| 0.0051|     |     |
| Rapseed    | 50            | 35 bu                        | 3.60| 0.79| 0.76|     |     |     | 0.68| 0.0001| 0.0008|
|            |               | 3 T. straw                   | 4.48| 0.43| 3.37| 1.47| 0.06| 0.17| 0.0017| 0.0021| 0.0017|
| Soybeans   | 60            | 35 bu                        | 6.25| 0.64| 1.90| 0.29| 0.29| 0.25| 0.0010| 0.0115| 0.0038|
|            |               | 2 T. stover                  | 2.25| 0.22| 1.04| 1.00| 0.45| 0.17| 0.0022|     |     |
| Sunflower  | 25            | 1.100 lb                     | 3.57| 1.71| 1.11| 0.18| 0.34| 0.17| 0.0022|     |     |
|            |               | 4 T. stover                  | 1.50| 0.18| 2.92| 1.73| 0.09| 0.04| 0.0241|     |     |</p>
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<th>Crop</th>
<th>Typical yield/acre plant part</th>
<th>Average concentration of nutrients (%)</th>
<th>Cu</th>
<th>Mn</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>P</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiber crops</td>
<td>% of the dry harvested material</td>
<td></td>
<td></td>
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<td></td>
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<td>Cotton</td>
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<td>0.58</td>
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<td>burs &amp; stalks</td>
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<td>0.12</td>
<td>0.02</td>
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<tr>
<td></td>
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<td>0.12</td>
<td>0.02</td>
<td>0.06</td>
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<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forage crops</td>
<td>% of the dry harvested material</td>
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<td></td>
<td></td>
<td></td>
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<td>1.27</td>
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<td>1.73</td>
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<td>0.99</td>
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<td>0.43</td>
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<td>1.52</td>
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<td>Dallisgrass</td>
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<td>1.40</td>
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<tr>
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<td>1.00</td>
<td>0.85</td>
<td>1.20</td>
</tr>
<tr>
<td>Lespedeza</td>
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<td>2.33</td>
<td>0.21</td>
<td>1.06</td>
</tr>
<tr>
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<td></td>
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<td>0.47</td>
<td>1.87</td>
</tr>
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<td>Paragrass</td>
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<td>0.82</td>
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<td>Red clover</td>
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<tr>
<td>Reed canarygrass</td>
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<td>0.18</td>
<td>0.36</td>
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<td>Ryegrass</td>
<td>5 tons</td>
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<td>Switchgrass</td>
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<td>1.15</td>
<td>0.10</td>
<td>1.90</td>
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<td>Tall fescue</td>
<td>3.5 tons</td>
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<td>1.97</td>
<td>0.20</td>
<td>2.00</td>
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<tr>
<td>Timothy</td>
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<td>0.22</td>
<td>1.58</td>
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<td>Wheatgrass</td>
<td>1 ton</td>
<td></td>
<td>1.42</td>
<td>0.27</td>
<td>2.68</td>
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Forest % of the dry harvested material

Leaves 0.75 0.06 0.46
Northern hardwoods 50 tons 0.20 0.02 0.10 0.29
Douglas fir 76 tons 0.16
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<tr>
<th>Crop</th>
<th>Dry wt. yield/acre</th>
<th>Typical plant part</th>
<th>Average concentration of nutrients (%)</th>
<th>% of the fresh harvested material</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>P</td>
</tr>
<tr>
<td>Fruit crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>12 tons</td>
<td>0.13</td>
<td>0.02</td>
<td>0.16</td>
</tr>
<tr>
<td>Bananas</td>
<td>9,900 lb.</td>
<td>0.19</td>
<td>0.02</td>
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<td>Cantaloupe</td>
<td>17,500 lb.</td>
<td>0.22</td>
<td>0.09</td>
<td>0.46</td>
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<td>Coconuts</td>
<td>0.5 tons-dry copra</td>
<td>5.00</td>
<td>0.60</td>
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</tr>
<tr>
<td>Grapes</td>
<td>12 tons</td>
<td>0.28</td>
<td>0.10</td>
<td>0.50</td>
</tr>
<tr>
<td>Oranges</td>
<td>54,000 lb.</td>
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<td>0.02</td>
<td>0.21</td>
</tr>
<tr>
<td>Peaches</td>
<td>15 tons</td>
<td>0.12</td>
<td>0.03</td>
<td>0.19</td>
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<tr>
<td>Pineapple</td>
<td>17 tons</td>
<td>0.43</td>
<td>0.35</td>
<td>1.68</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>22 tons</td>
<td>0.30</td>
<td>0.04</td>
<td>0.33</td>
</tr>
<tr>
<td>Silage crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa haylage (50% dm)</td>
<td>10 wet/5 dry</td>
<td>2.79</td>
<td>0.33</td>
<td>2.32</td>
</tr>
<tr>
<td>Corn silage (35% dm)</td>
<td>20 wet/7 dry</td>
<td>1.10</td>
<td>0.25</td>
<td>1.09</td>
</tr>
<tr>
<td>Forage sorghum (30% dm)</td>
<td>20 wet/6 dry</td>
<td>1.44</td>
<td>0.19</td>
<td>1.02</td>
</tr>
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<td>Oat haylage (40% dm)</td>
<td>10 wet/4 dry</td>
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<td>0.28</td>
<td>0.94</td>
</tr>
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<td>Sorghum-sudan (50% dm)</td>
<td>10 wet/5 dry</td>
<td>1.36</td>
<td>0.16</td>
<td>1.45</td>
</tr>
<tr>
<td>Sugar crops</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>37 tons</td>
<td>0.16</td>
<td>0.04</td>
<td>0.37</td>
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<tr>
<td>Sugar beets</td>
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<td>0.20</td>
<td>0.03</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.43</td>
<td>0.04</td>
<td>1.03</td>
</tr>
<tr>
<td>Tobacco</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>All types</td>
<td>2,100 lb.</td>
<td>3.75</td>
<td>0.33</td>
<td>4.98</td>
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<td>Turf grass</td>
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<td></td>
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<tr>
<td>Bluegrass</td>
<td>2 tons</td>
<td>2.91</td>
<td>0.43</td>
<td>1.95</td>
</tr>
<tr>
<td>Bentgrass</td>
<td>2.5 tons</td>
<td>3.10</td>
<td>0.41</td>
<td>2.21</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>4 tons</td>
<td>1.88</td>
<td>0.19</td>
<td>1.40</td>
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</table>
APPENDIX E
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<tr>
<th>FIELD CROPS</th>
<th>YIELD</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
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<tr>
<td>Barley</td>
<td>2 1/2 t.</td>
<td>160</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>Canola (whole plant)</td>
<td>4,000 lbs</td>
<td>240</td>
<td>120</td>
<td>190</td>
</tr>
<tr>
<td>Corn (grain)</td>
<td>5 t.</td>
<td>240</td>
<td>100</td>
<td>240</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>30 t.</td>
<td>250</td>
<td>105</td>
<td>250</td>
</tr>
<tr>
<td>Cotton (lint)</td>
<td>1,500 lbs.</td>
<td>180</td>
<td>65</td>
<td>125</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>4 t.</td>
<td>250</td>
<td>90</td>
<td>200</td>
</tr>
<tr>
<td>Oats</td>
<td>3,200 lbs.</td>
<td>115</td>
<td>40</td>
<td>145</td>
</tr>
<tr>
<td>Rice</td>
<td>7,000 lbs.</td>
<td>110</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Safflower</td>
<td>4,000 lbs.</td>
<td>200</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>Sugar Beets</td>
<td>30 t.</td>
<td>255</td>
<td>60</td>
<td>550</td>
</tr>
<tr>
<td>Wheat</td>
<td>3 t.</td>
<td>175</td>
<td>70</td>
<td>200</td>
</tr>
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<td>3,000 lbs.</td>
<td>95</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>Beans (snap)</td>
<td>10,000 lbs.</td>
<td>175</td>
<td>40</td>
<td>200</td>
</tr>
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<td>Broccoli</td>
<td>18,000 lbs.</td>
<td>80</td>
<td>30</td>
<td>75</td>
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<td>Cabbage</td>
<td>35 t.</td>
<td>270</td>
<td>65</td>
<td>250</td>
</tr>
<tr>
<td>Celery</td>
<td>75 t.</td>
<td>280</td>
<td>165</td>
<td>750</td>
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<td>Lettuce</td>
<td>20 t.</td>
<td>95</td>
<td>30</td>
<td>200</td>
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<tr>
<td>Potatoes (Irish)</td>
<td>500 cwt.</td>
<td>270</td>
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<td>550</td>
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<td>120</td>
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<tr>
<td>Sweet potatoes</td>
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<td>155</td>
<td>70</td>
<td>315</td>
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<tr>
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<td>180</td>
<td>50</td>
<td>340</td>
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<td>Almonds (in shell)</td>
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<td>75</td>
<td>250</td>
</tr>
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<td>Apples</td>
<td>15 t.</td>
<td>120</td>
<td>55</td>
<td>215</td>
</tr>
<tr>
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<td>220</td>
<td>70</td>
<td>400</td>
</tr>
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<td>15 t.</td>
<td>125</td>
<td>45</td>
<td>195</td>
</tr>
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<td>30 t.</td>
<td>265</td>
<td>55</td>
<td>330</td>
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<td>40</td>
<td>120</td>
</tr>
<tr>
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<td>15 t.</td>
<td>85</td>
<td>25</td>
<td>95</td>
</tr>
<tr>
<td>Prunes</td>
<td>15 t.</td>
<td>90</td>
<td>30</td>
<td>130</td>
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<td>Alfalfa</td>
<td>8 t.</td>
<td>480</td>
<td>95</td>
<td>480</td>
</tr>
<tr>
<td>Brome grass</td>
<td>5 t.</td>
<td>220</td>
<td>65</td>
<td>315</td>
</tr>
<tr>
<td>Clover-grass</td>
<td>6 t.</td>
<td>300</td>
<td>90</td>
<td>360</td>
</tr>
<tr>
<td>Oats**</td>
<td>12 t.</td>
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<td></td>
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<tr>
<td>Orchard grass</td>
<td>6 t.</td>
<td>300</td>
<td>100</td>
<td>375</td>
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<tr>
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<td>8 t.</td>
<td>325</td>
<td>125</td>
<td>475</td>
</tr>
<tr>
<td>Timothy</td>
<td>4 t.</td>
<td>150</td>
<td>55</td>
<td>250</td>
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<td>Vetch</td>
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<td>105</td>
<td>320</td>
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<td>TURF CROPS</td>
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</tr>
<tr>
<td>Bent grass</td>
<td>2 1/2 T.</td>
<td>225</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>Bermuda grass</td>
<td>4 T.</td>
<td>225</td>
<td>40</td>
<td>160</td>
</tr>
</tbody>
</table>

Levels of Nitrogen utilization are proportional to crop yield and can be adjusted accordingly.

* From Western Fertilizer Handbook (1995)  ** Cooperative Extension Recommendation
State of the Air: 2001
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INTRODUCTION

Americans closed the 1990s with a great sense of expectation. We have seen advances all around us—medical discoveries, technological innovations—so it's only natural for us to expect progress in efforts to clean up the air that we breathe. But the American Lung Association has found, through a careful analysis of environmental data, that we are not yet winning the fight for clean air. In fact, the American Lung Association's State of the Air 2001 finds some very disturbing trends in air quality.

Last year, the American Lung Association initiated its State of the Air annual assessment to provide citizens with easy-to-understand air pollution summaries of the quality of the air in their communities that are based on concrete data and sound science. Air quality in cities and counties is assigned a grade ranging from “A” through “F” based on how often their air pollution levels exceed the “unhealthy” categories of the U.S. Environmental Protection Agency’s Air Quality Index for ground-level ozone (smog) pollution. The Air Quality Index is, in turn, based on the national air quality standards. The air quality standard for ozone used as the basis for this report, 80 parts per billion averaged over an eight-hour period, was adopted by the EPA in 1997 based on the most recent health effects information. The grades in this report are assigned based on the quality of the air in areas, and do not reflect an assessment of efforts to implement controls that improve air quality.
EXECUTIVE SUMMARY

*State of the Air 2000* confirmed that air pollution remains a major threat to Americans, contributing substantially to the nation’s ill health burden. *State of the Air 2001* finds that since last year’s report, many more people are breathing in unhealthy air:

- The number of Americans living in areas that received an “F” in this report increased by more than 9 million compared with last year’s report—from 132 million to more than 141 million. This figure represents approximately 75 percent of the nation’s population who live in counties where there are ozone monitors.

- More than 30 million children under age 14—whose lungs are particularly vulnerable to the effects of ozone-filled air—are living in counties that received an “F” in air quality. That’s 1.6 million more children who live in areas with “failing” air quality than last year.

- More than 17 million Americans over age 65—another group at particular risk of suffering health problems from dirty air—live in areas that received an “F”. That’s over one million more elderly at risk than last year.

- 3.6 million adults with asthma, and 1.9 million children with asthma, live in counties that received an “F” rating.

- The number of U.S. counties that received an “F” in air quality jumped 15 percent from last year—from 333 to 382 counties. That means that more than half of the counties where there are ozone monitors received a failing grade.

- The total number of high ozone days in the “F” range jumped 25.3 percent in monitored counties.

- *State of the Air 2001* found that according to the Environmental Protection Agency’s Air Quality Index, there were a total of 12,805 “Orange” (unhealthy for sensitive groups) days in counties being monitored for ozone in 1997 to 1999—a jump of 25% from the *State of the Air 2000* report. The number of “Red” (unhealthy) days rose 11% during the same period. “Purple” (very unhealthy) days decreased slightly, from 219 in the 2000 report to 209 in this year’s report.

*State of the Air 2000* focused on ozone levels for the years 1996-1998, while *State of the Air 2001* looks at 1997-1999 data. This represents the most recent available complete ozone monitoring data that has been fully reviewed by the EPA for quality assurance at the time this report was prepared. The hot summer weather of 1999 increased the amount of ozone in the air in many parts of the country, and made breathing more difficult for many Americans. But clearly there was no significant drop in emissions of the air pollutants that form ozone, also known as smog, to compensate for the increased ozone generated by the hot summer of 1999. We will need a major reduction in emissions if we want our most vulnerable citizens to survive hot summers without having to struggle to breathe due to ozone pollution. Further, recent predictions of a trend toward hotter summers in the future for much of the United States due to the effects of global climate change will likely worsen the nation’s ozone problem unless future reductions in ozone-forming pollution are sufficient to compensate for the warmer temperatures.
The stakes are high: scientists have estimated that the number of deaths in the United States associated with air pollution range from 50,000 to 100,000 per year\(^1\). While particulate matter is the form of air pollution most prominently linked to premature death, there is increasing evidence that ozone pollution may also have a role in this most serious of health outcomes. A study of air pollution and daily mortality in London between 1987 and 1992 found that same-day ozone levels were associated with a significant increase in mortality due to all causes, and with cardiovascular and respiratory deaths in particular. The effects were independent of the effects of other pollutants.\(^2\) And a study conducted in Amsterdam found a link between a day's ozone levels and the death rate two days later.\(^3\)

For every 75 deaths per year due to air pollution, health scientists have estimated that there are 265 hospital admissions for asthma and 240 non-asthma respiratory admissions, 3,500 respiratory emergency doctor visits, 180,000 asthma attacks, 930,000 restricted activity days, and 2,000,000 acute respiratory symptom days\(^4\).
NATIONWIDE AND REGIONAL TRENDS

Most areas that were found to be the most ozone-polluted in State of the Air 2000 didn't fare any better in State of the Air 2001. Only three cities from last year's report dropped off the list of America's 25 most ozone-polluted cities: Modesto, California; Birmingham, Alabama; and St. Louis, Missouri (However, the air quality in these cities continue to receive a failing grade). Five new cities appear this year: Richmond-Petersburg, Virginia; Baron Rouge, Louisiana; Louisville, Kentucky; Greensboro-Winston-Salem-High Point, North Carolina; and Chattanooga, Tennessee.

The similar findings in the 2000 and 2001 reports indicate that the high levels of ozone around the country found in State of the Air 2000 were not an anomaly. The two reports taken together show that high ozone levels are an ongoing, widespread national problem that affects a significant portion of the U.S. population.

Nationwide Danger. As with last year's report, State of the Air 2001 finds that ozone levels violate the health-based standards of the Clean Air Act in major cities and counties throughout the United States. From San Diego to Houston to Atlanta to Philadelphia, ozone-filled air threatens the ability of people with asthma, chronic bronchitis and emphysema to breathe easily. Big cities such as New York and Los Angeles, smaller cities like Lancaster, Pennsylvania and Redding, California, and medium-sized cities, such as Memphis and Charlotte, all carry the burden of smog-filled air. Some cities suffer from high levels of ozone air pollution because of local traffic and industry, while other areas without major industry or large populations must breathe in pollution blown in from other communities.

This report demonstrates that ozone air pollution isn't just a problem in isolated areas of the country. Southeastern and Mid-Atlantic cities are on the list of the highest-ozone cities, along with the better-known pollution centers such as Los Angeles and Houston. Atlanta jumped from the 9th to the 6th worst polluted city, Knoxville, Tennessee jumped to the 9th worst city from 12th, while the Philadelphia and Raleigh-Durham, North Carolina areas tied for 10th place, a jump from 13th and 17th place, respectively.

Slightly Better News in California. In general, the news was better this year, but only relatively, for California, which has the dubious distinction of having the most counties (11) on the most-polluted counties list—down from 14 last year. But even with fewer counties on the list, the top five—San Bernardino, Riverside, Kern, Fresno and Tulare—are all in California. San Diego, Sacramento and Shasta Counties dropped off the list of the 25 most ozone-polluted. Los Angeles County, number 5 last year on the list of America's 25 most ozone-polluted counties, moved down to number 8 in the new report. Also encouraging for the state: San Diego dropped from number 6 down to 17 on the list of America's 25 most ozone-polluted cities. The improvement in California's area air quality is likely due to both reduced ozone precursor emissions from pollution controls and weather conditions less favorable to ozone formation in 1999.

Spreading Problem in Some States. State of the Air 2001 found that three states—North Carolina, Georgia and Maryland—have more counties on this year's list of America's 25 most ozone-polluted counties compared with last year. In North Carolina, Rowan County joined Mecklenburg and Wake Counties; in Maryland,
Charles County joined Anne Arundel and Prince George's; and in Georgia, Douglas County joined Fulton and Rockdale.

The Cleanest Air. Most of the areas that were rated as having the best record on ozone air pollution, reporting no days in the unhealthy ranges, in last year’s report again rated highly this year. Bellingham, Washington; Colorado Springs, Colorado; Des Moines, Iowa; and Duluth, Minnesota, all made the list of clean cities for both the 2000 and 2001 reports.
Table 1: Estimated Populations at Risk by Grading Level, 2000 and 2001

State of the Air Reports

<table>
<thead>
<tr>
<th>Population At-Risk</th>
<th>Grade A (0.0)</th>
<th>Grade B (0.3-0.9)</th>
<th>Grade C (1.0-2.0)</th>
<th>Grade D (2.1-3.2)</th>
<th>Grade F (3.3+)</th>
<th>National Population</th>
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<td>9,582,029</td>
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<td>48</td>
<td>41</td>
<td>50</td>
<td>58</td>
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<tr>
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<td>*</td>
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<td>Emphysema</td>
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<td>Number of High Ozone Days</td>
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<td></td>
<td></td>
<td></td>
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<td>67</td>
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Note:
1. Chronic disease estimates for 2000 and 2001 CANNOT BE COMPARED TO EACH OTHER. Between the release dates of these two publications, the National Health Interview Survey (the source of information on the prevalence of chronic disease in the civilian, noninstitutionalized, household population of the US) completely redsigned their questionnaire, and this prevents any comparison in disease trends. Therefore, estimated prior to 1997 cannot be compared with later estimates. The 2000 estimates were obtained from the 1996 NHIS survey while the 2001 estimates were obtained from the revised NHIS survey. This accounts for the difference seen in estimates for both years.
### Table 2: Comparison of Number of Counties and High Ozone Days, 2000-2001

<table>
<thead>
<tr>
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<td>%</td>
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<td>55</td>
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<td>B</td>
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<td>7.1</td>
<td>41</td>
</tr>
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<td>C</td>
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</tr>
<tr>
<td>D</td>
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<td>8.0</td>
<td>41</td>
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<td>F</td>
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<td>49.1</td>
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<tr>
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<th>2001</th>
<th>% Difference</th>
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<td>11,826</td>
<td>14,519</td>
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Note: * indicates incomplete monitoring data for all three years. Therefore, those counties are excluded from the grade analysis.
<table>
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<th>CMSSA</th>
<th>2001 Rank</th>
<th>2008 Rank</th>
<th>Total Population</th>
<th>Under 14</th>
<th>Over 65</th>
<th>Pediatric Asthma</th>
<th>Adult Asthma</th>
<th>Chronic Bronchitis</th>
<th>Emphysema</th>
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<td>1</td>
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Adding across rows does not produce valid estimates except for the calculation of pediatric and adult asthma.
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<th>2001 Rank</th>
<th>2000 Rank</th>
<th>Total Population</th>
<th>Under 14</th>
<th>Over 65</th>
<th>Pediatric Asthma</th>
<th>Adult Asthma</th>
<th>Adult Chronic Bronchitis</th>
<th>Adult Emphysema</th>
<th>Orange</th>
<th>Red</th>
<th>Purple</th>
<th>Weighted Avg</th>
<th>Grade</th>
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<td>12</td>
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<td>967,67</td>
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<td>99,425</td>
<td>17,899</td>
<td>1,671</td>
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<td>4,259</td>
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<td>13,850</td>
<td>3,545</td>
<td>7,045</td>
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<td>1,435</td>
<td>8</td>
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<td>4,352</td>
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<td>1,962</td>
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<td>23</td>
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<td>29,526</td>
<td>89,524</td>
<td>6,528</td>
<td>1,396</td>
<td>2,641</td>
<td>3,747</td>
<td>1,235</td>
<td>67</td>
<td>27.6</td>
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</tr>
<tr>
<td>Prince George's</td>
<td>MD</td>
<td>24</td>
<td>24</td>
<td>775,607</td>
<td>164,936</td>
<td>610,670</td>
<td>10,457</td>
<td>20,013</td>
<td>28,394</td>
<td>6,701</td>
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<td>22</td>
<td>393,369</td>
<td>90,367</td>
<td>303,002</td>
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<td>5,556</td>
<td>9,554</td>
<td>12,600</td>
<td>4,154</td>
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</tbody>
</table>

Note:
(1) The weighted average was derived by adding the three years of individual level data (1997-1999), multiplying the sum of each level by the assigned standard weights, i.e. 1=orange, 1.5=red, 2=purple, and calculating the average.
### Table 5a: Counties with the Worst Ozone Air Pollution in Each State

<table>
<thead>
<tr>
<th>County</th>
<th>ST</th>
<th>Metropolitan Statistical Area</th>
<th>Number of High Ozone Days in the Unhealthy Range, 1997-1999</th>
<th>Weighted Avg (1)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyandotte</td>
<td>KS</td>
<td>Kansas City, MO-KS, MSA</td>
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<td>1</td>
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</tr>
<tr>
<td>King</td>
<td>WA</td>
<td>Seattle-Bellevue-Everett, WA, PMSA</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Dona Ana</td>
<td>NM</td>
<td>Las Cruces, NM, MSA</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jackson</td>
<td>OR</td>
<td>Medford-Ahland, OR, MSA</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bennington</td>
<td>VT</td>
<td>N/A</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scott</td>
<td>IA</td>
<td>Davenport-Molina-Rock Island, IA-IL, MSA</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Douglas</td>
<td>NE</td>
<td>Omaha, NE-IA, MSA</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anoka</td>
<td>MN</td>
<td>Minneapolis-St. Paul, MN-WI MSA</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Washington</td>
<td>MN</td>
<td>Minneapolis-St. Paul, MN-WI MSA</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

**Note:**

(1) The weighted average was derived by adding the three years of individual level data (1997-1999), multiplying the sums of each level by the assigned standard weights, i.e. 1=orange, 1.5=red, 2.0=purple, and calculating the average.
### Table 6:
**Cities and Counties Deleted from the Lists of the 25 Most Ozone-Polluted Cities and Counties Between 2000 and 2001**

<table>
<thead>
<tr>
<th>City</th>
<th>2000 Rank</th>
<th>2000 Grade</th>
<th>2001 Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modesto, CA, MSA</td>
<td>20</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Birmingham, AL, MSA</td>
<td>24</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>St. Louis, MO-IL, MSA</td>
<td>25</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>County</th>
<th>2000 Rank</th>
<th>2000 Grade</th>
<th>2001 Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Diego, CA</td>
<td>15</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Sacramento, CA</td>
<td>20</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Shasta, CA</td>
<td>23</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Ocean, NJ</td>
<td>24</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Jefferson, TN</td>
<td>25</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Sumner, TN</td>
<td>25</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>
**Table 7: Metropolitan Areas with No Monitored Ozone Air Pollution Levels in Unhealthy Ranges**

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Population</th>
</tr>
</thead>
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<tr>
<td>Bellingham, WA, MSA</td>
<td>157,244</td>
</tr>
<tr>
<td>Colorado Springs, CO, MSA</td>
<td>490,044</td>
</tr>
<tr>
<td>Des Moines, IA, MSA</td>
<td>436,787</td>
</tr>
<tr>
<td>Duluth Superior, MN-WI, MSA</td>
<td>236,591</td>
</tr>
<tr>
<td>Fargo-Moorhead, ND-MN, MSA</td>
<td>168,410</td>
</tr>
<tr>
<td>Flagstaff, AZ-UT, MSA</td>
<td>120,306</td>
</tr>
<tr>
<td>Honolulu, HI, MSA</td>
<td>871,768</td>
</tr>
<tr>
<td>Laredo, TX, MSA</td>
<td>186,798</td>
</tr>
<tr>
<td>Lincoln, NE, MSA</td>
<td>235,537</td>
</tr>
<tr>
<td>McAllen-Edinburg-Mission, TX, MSA</td>
<td>519,661</td>
</tr>
<tr>
<td>Salinas, CA, MSA</td>
<td>366,631</td>
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<tr>
<td>Spokane, WA, MSA</td>
<td>408,221</td>
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</tbody>
</table>

Note: MSA's were included only if all their respective counties with monitoring sites received a grade of A. Metropolitan areas are listed in alphabetical order; they are not ranked.
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<th>State</th>
<th>Metropolitan Statistical Area</th>
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<td>N/A</td>
</tr>
<tr>
<td>Cochise</td>
<td>AZ</td>
<td>N/A</td>
</tr>
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<td>Coconino</td>
<td>AZ</td>
<td>Flagstaff, AZ-UT, MSA</td>
</tr>
<tr>
<td>Lake</td>
<td>CA</td>
<td>N/A</td>
</tr>
<tr>
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<td>CA</td>
<td>San Francisco, CA, PMSA</td>
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<td>Salinas, CA, MSA</td>
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<tr>
<td>Plumas</td>
<td>CA</td>
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<tr>
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<td>CA</td>
<td>San Francisco, CA, PMSA</td>
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<tr>
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<td>CA</td>
<td>Santa Cruz-Watsonville, CA, PMSA</td>
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<td>Siskiyou</td>
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<td>CO</td>
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N/A = Not Applicable
Table 9: Breakdown of High Ozone Days Among Counties with Monitoring Sites

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<td>(that were excluded in the analysis)</td>
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Dade County is now called Miami-Dade.
Cook replaces Madison as worst county.
Clark replaces Warren as worst county.
E. Baton Rouge replaces Barville as worst county.
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Table 10c: State Comparisons, 2000-2001

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Notes: * indicates incomplete monitoring data for all three years. Therefore, those counties are excluded from the grade analysis.

1) The "grade changes" column represents counties that have either increased or decreased by a grade within the past year, i.e. going from a B to an A or a C to a D. This column does not include counties that had increases or decreases in their weighted averages but did not change an actual grade level.
HEALTH EFFECTS OF OZONE

The American Lung Association *State of the Air* reports focus on ozone, one of the most dangerous of the common air pollutants. As this report proves, ozone plagues many areas of the country and many U.S. cities, both large and small. As of 1998, 92.5 million Americans still lived in areas classified as not meeting the earlier one-hour national ozone standard of 0.12 parts per million.5

The Lung Association also chose to focus on ozone because there is better historical data on ozone levels compared with some of the other common air pollutants, which makes it easier to observe trends over time. Although ozone levels can fluctuate from year to year due to meteorological conditions, lack of a downward trend over several years in a given geographical area can be an indication that neither the government nor polluting companies are making a concerted effort to reduce pollution.

The Dangers of Ozone. Ozone is a powerful respiratory irritant at the levels frequently found in most of the nation's urban areas during summer months. Symptoms include shortness of breath, chest pain when inhaling deeply, wheezing and coughing. Research on the effects of prolonged exposures (6 ½ hours) to relatively low levels of ozone have found reductions in lung function, biological evidence of inflammation of the lung lining and respiratory discomfort. In studies of animals, ozone exposure has been found to increase susceptibility to bacterial pneumonia infection. One study of 16 Canadian cities over a 10-year period found that air pollution, including ozone, at relatively low concentrations, is associated with excess admissions to the hospital for respiratory diseases.6

Ozone levels typically rise during the May through September period when higher temperatures and the increased amount of sunlight combine with the stagnant atmospheric conditions that are associated with ozone air pollution episodes.

Recently, attention has begun to focus on the effects of long-term, repeated exposures to high levels of ozone. A study of college freshmen who were lifelong residents of Northern or Southern California found a strong relationship between lifetime ozone exposure and reduced lung function.7 Additional evidence comes from a study of 72 cadets at the U.S. Military Academy at West Point, who attended a summer training program in which they spent an average of 11 hours a day outdoors. The study found that the 21 cadets who attended summer training in Fort Dix, New Jersey, an area with elevated ozone levels, had a larger drop in lung function over the summer, compared with the cadets who trained at sites in Georgia, Missouri and Oklahoma with lower ozone levels.8

Long-term exposures of animals to moderate ozone levels produce changes in the structure of the lung. A recent study of 1,150 children followed for three years suggests that long-term ambient ozone exposure might negatively affect human lung function growth. The researchers observed small but consistent decrements in lung function in the children that were associated with ambient ozone exposure.9

High ozone levels are particularly dangerous for people with asthma. When ozone levels are high, more people with asthma suffer asthma attacks that require a doctor's visit or use of extra medication. Just one example of how many people can be affected by high ozone levels: *State of the Air 2001* found that in the Los Angeles-Riverside-Orange County area, rated the most ozone-polluted city in the United States based on 1997-
99 levels, approximately 400,000 adults and 230,000 children suffer from asthma.

A recent study underscores the benefits of reducing ozone and other air pollutants for people with asthma. Researchers compared the number of asthma-related hospital emergency department and urgent care center visits, as well as hospital admissions, for children under age 17 in Atlanta before, during and after the 1996 Olympics. The study concluded that the reduced traffic levels due to traffic controls implemented during the Olympics "...was associated with a prolonged reduction in ozone pollution and significantly lower rates of childhood asthma events." 10

Children at Risk. A number of recent studies have added to the evidence that children are especially vulnerable to the harmful effects of ozone. Children spend significantly more time outdoors, especially in the summertime when ozone levels are the highest. Children also spend more time engaged in exercise, and such activity results in breathing in more air, and therefore more pollution being taken deep into the lungs.

One study found that when air pollution worsens, more children stay home sick from school due to respiratory illnesses. The University of Southern California researchers found that school absences due to sore throats, coughs, asthma attacks and similar problems increase in the three to five days after a significant rise in ozone. 11 Another study of schoolchildren in Nevada also found that increases in ozone levels was associated with an increase in the school absentee rate. 12

Children with asthma are particularly susceptible to ozone. Researchers at the University of Southern California conducted a 10-year prospective study of Southern California public school children, and found a statistically significant association between ozone exposure and decreased lung function in girls with asthma. 13 Another recent study found asthmatic children who had a low birthweight or a premature birth are especially susceptible to the effects of summer ozone. 14

The Elderly. As we age, our breathing ability diminishes over time. So even the healthy elderly are at increased risk from exposure to ozone and other air pollutants, which can further reduce their lung function. Ozone air pollution also increases susceptibility to influenza, pneumonia and other infections, which are especially dangerous for the elderly. A study of the relationship between daily death rates in the elderly, outdoor air temperatures and ozone levels in Belgium confirms the deadly potential of ozone for senior citizens. The study demonstrated a statistical association between daily mortality in the elderly and ambient ozone concentration during the hot summer of 1994. 15 In addition, ozone can significantly worsen the condition of people with chronic bronchitis and emphysema, and since most of these diseases occur in the elderly population, these elderly are at special risk for exposure to ozone.

Ozone and the Air Quality Index. The Air Quality Index (AQI), established by the U.S. Environmental Protection Agency, is used by state and local agencies to report levels of air pollution. The AQI divides ambient concentrations of air pollution into categories, assigning each one a descriptor and color: Green (good); Yellow (moderate); Orange (unhealthy for sensitive groups); Red (unhealthy) Purple (very unhealthy). The American Lung Association defines sensitive groups for ozone to include children, the elderly, people with lung disease including asthma, outdoor workers, and healthy adults who exercise outdoors.
Ozone and Other Pollutants. A recent study found that ozone increases the damaging effect of diesel exhaust particles in the lungs of rats. Ozone also has been shown to increase allergic responses in people with asthma or allergies. One study found that people with allergies who first breathed in ozone and then inhaled allergens experienced a 7.8% decrease in lung function; those who breathed in filtered air and then allergens had only a 1.3% decrease. Another study looked at allergic asthmatics (people whose asthma is triggered by allergies) who were exposed to ozone, and then had allergens applied to one nostril and saline to the other. The researchers found that ozone “primed” the nose for allergic responses, and induced inflammation in the nasal airways.
ATTACKING THE NATION'S OZONE PROBLEM

Overview of Ozone Sources. Ozone is a highly reactive gas that is a form of oxygen. It is the main component of the air pollution known as smog. Ozone reacts chemically ("oxidizes") with internal body tissues that it comes in contact with, such as those in the lung.

Ozone is formed by the action of sunlight on carbon-based chemicals known as hydrocarbons, acting in combination with a group of air pollutants called oxides of nitrogen (NOx). Hydrocarbons are emitted by motor vehicles, oil and chemical storage and handling facilities, and a variety of commercial and industrial sources such as gas stations, dry cleaners and degreasing operations. Oxides of nitrogen are a by-product of burning fuel in sources such as power plants, steel mills and other heavy industry and in motor vehicles.

Wind can carry NOx hundreds of miles, so people who don't live in areas with high levels of NOx emissions aren't necessarily safe from these emissions. EPA has been tracking NOx and five other major air pollutants since 1970, and found that while carbon monoxide, lead, particulate matter, sulfur dioxide, and volatile organic compounds have decreased significantly, NOx emissions have increased approximately 10 percent.
CONTROL STRATEGIES

New Diesel Regulations. In January 2001, the Environmental Protection Agency issued new regulations that will help millions of Americans, especially children with asthma, breathe easier. The regulations significantly limit tailpipe emissions from heavy-duty diesel vehicles.

The new rule will cap sulfur levels in diesel fuel at 15 parts per million (ppm) and impose tough new emissions standards on all heavy-duty vehicles. This will result in a more than 90 percent reduction in emissions of harmful pollutants like particulate matter (PM) and nitrogen oxides (NOx). Particulate matter has been linked to premature death and worsening asthma, and nitrogen oxides are a principal component of ozone smog.

The oil industry had tried to water down the rules by offering an alternative proposal with higher sulfur levels. That plan would have severely weakened the program and precluded significant reductions of nitrogen oxides and particulate matter pollution. In response to the new sulfur in diesel fuel regulations, the National Petroleum Refiners Association filed a lawsuit challenging the new EPA regulations in February 2001. The American Lung Association has intervened in this lawsuit to support the EPA heavy-duty diesel regulations.

Public opinion stands behind the clean up of dirty diesel buses and trucks. In a recent American Lung Association survey, nearly nine of ten voters (87 percent) favored requiring production of cleaner diesel fuel and 84 percent of voters said it is personally important to them to require the production of cleaner diesel fuel. Likewise, nearly nine of ten (85 percent) of voters favored requiring 18-wheelers and other big diesel vehicles to use the best available pollution control technology, even if it costs them more money.

In addition, voters also believe cleaner diesel fuel can have a positive impact on our nation's air quality. More than three fourths of voters (77 percent) believe cleaner diesel fuel will make a difference in cleaning up air pollution.

Voters also favored diesel fuel cleanup even when told it would increase costs to consumers. After hearing statements on both sides of the issue, two-thirds of voters (65 percent) agreed with the statement that “cleaner diesel fuel is necessary to significantly reduce air pollution from big trucks and buses and is worth it even if it costs consumers a little more,” versus only 16 percent who agreed that “cleaner diesel fuel for big trucks and buses will be too expensive resulting in higher costs which will be passed on to consumers.”

Non-road Heavy Duty Engines. While new rules to regulate emissions of on-road heavy-duty diesels will make a great deal of difference in the quality of our air, these rules alone will not be enough. EPA must also take steps to control non-road heavy-duty diesel engines, such as construction equipment, and clean up the diesel fuel used in these engines. In fact, non-road heavy-duty diesel engines are a more significant source of emissions than on-road heavy-duty diesels.

PM$_{10}$ emission from non-road vehicles and engines accounted for 64% of transportation source emissions and 16% of total emissions; for NOx, they account for 40% of transportation source emissions and 22% of total emissions.

Non-road heavy-duty diesel equipment can benefit from the technological advances that will occur in order to meet the 2007 on-road standards—but only if low-sulfur diesel fuel, which is necessary for these technologies to operate, is available for the non-road sector, as well. That's why the EPA should adopt emission...
standards and a sulfur cap for non-road heavy-duty diesels and fuel that are equivalent to those for on-road heavy-duty diesels, and in the same time frame.

**National Air Quality Standards.** On February 27, 2001, the Supreme Court ruled unanimously that the EPA process of setting air quality standards was constitutional, and that costs could not be considered in the standard-setting process. At issue are 1997 standards set by the Environmental Protection Agency (EPA) for ozone (smog) and particles (soot). The EPA estimates the standards will each year prevent thousands of premature deaths, tens of thousands of hospitalizations and other illnesses for respiratory and cardiovascular causes, and millions of days of missed work and school. The standards were challenged by industry and three states.

In 1999, the U.S. Court of Appeals for the DC Circuit ruled that the EPA's interpretation of the Clean Air Act represents an unconstitutional delegation of Congress' legislative authority. The American Lung Association intervened to oppose the challenges and filed briefs in support of the EPA's appeal to the Supreme Court. The Supreme Court also heard oral arguments in a related case in which industry argued for the Court to reverse a long-established legal precedent that bars inclusion of pollution control cost factors in the air quality standard-setting process. The Lung Association, which was a party in this case as well, strongly opposed the industry position as bad public health policy and also directly contravening the Clean Air Act. The Supreme Court did rule that EPA must reconsider how implementation of the 1997 eight-hour standard will be reconciled with implementation of the 1979 one-hour standard.

It is crucial that EPA revise the ozone standard implementation process quickly in order to minimize any further delay in protecting the public from ozone pollution. EPA also must expeditiously classify those areas that violate the eight-hour ozone standard so that states can move forward with identifying and implementing the pollution control strategies needed to meet the standard. Based on 1997-99 monitoring data, a report by the Clean Air Network estimated that almost 117 million Americans live in 333 counties that violate the eight-hour ozone standard.20

**Power Plants.** No other single source of pollution poses such danger to health and the environment as do coal-burning power plants. The damage continues to mount as the emissions of nitrogen oxides and sulfur dioxide have increased and the emissions of mercury, a toxic contaminant, and carbon dioxide, the foremost pollutant linked to global climate change, have continued unabated.

Since 1970, the Clean Air Act has exempted the oldest, dirtiest coal-burning power plants from complying with modern emissions standards. As a result, these older power plants are permitted to emit as much as 10 times more nitrogen oxides and sulfur dioxide as that of modern coal plants. Even worse, the entire industry is currently allowed to emit unlimited amounts of mercury and carbon dioxide. Power plants are the only unregulated source of toxic mercury air emissions.

This loophole in the Clean Air Act is now allowing power companies using these older facilities with outdated pollution controls to gain a competitive cost advantage over their competitors who are more environmentally friendly. As a result, the power industry is relying on these old plants more than ever: between 1992 and 1998, there was a 15.8% jump in the amount of electricity generated from old coal-fired power plants.

Legislation has been introduced in Congress that would finally close the 30-year old loophole for power plants and that would set reasonable and achievable caps on the four major pollutants.
ENDNOTES


19 The survey of 800 registered voters nationwide who indicated they voted in the November 2000 general election for President and Congress was conducted November 8-12, 2000 by Lake Snell Perry & Associates. The survey margin of error is plus or minus 3 ½ percent.

20 Clean Air Network; Smog Watch 2000; June, 2000.
Description of Methodology

Statistical Methodology: The Air Quality Data. The data on air quality throughout the United States was obtained from EPA’s Aerometric Information Retrieval System (AIRS) database. The American Lung Association used A.S.L. & Associates to analyze data on ozone monitoring for the three-year period 1997–1999. The 1997, 1998, and 1999 AIRS hourly ozone data was used to calculate the daily eight-hour maximum concentration for each ozone-monitoring site. The highest daily eight-hour daily maximum concentration in each county for 1997, 1998, and 1999 based on the EPA-defined ozone season was then determined.

Using these results a table summarizing the ozone data for each county for each of the three years the numbers within the following ranges:

<table>
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<tr>
<th>ppm</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000–0.064 ppm</td>
<td>Good (Green)</td>
</tr>
<tr>
<td>0.065–0.084 ppm</td>
<td>Moderate (Yellow)</td>
</tr>
<tr>
<td>0.085–0.104 ppm</td>
<td>Unhealthy for Sensitive Groups (Orange)</td>
</tr>
<tr>
<td>0.105–0.124 ppm</td>
<td>Unhealthy (Red)</td>
</tr>
<tr>
<td>0.125–0.374 ppm</td>
<td>Very Unhealthy (Purple)</td>
</tr>
</tbody>
</table>

Using these results, A.S.L. & Associates prepared a table that summarized for each of the three years the number of days the ozone level was within the unhealthy ranges identified by EPA as Orange, Red and Purple Days. The number of days within each of these categories was summed to establish the number of days each monitored county experienced air quality designated as orange, red or purple.

No data capture criteria were used to eliminate monitoring sites. All data were used in the analysis because it was the goal to identify the number of days that eight-hour daily maximum concentrations occurred within the defined ranges.

Description of County Grading System. A weighted average was used to determine the grades of each county. The calculation for the weighted average was as follows: The number of orange days experienced by each county was assigned a factor of 1; red days were assigned a factor of 1.5 and purple days were assigned a factor of 2. After multiplying the total number of days within each category by their assigned factor, a total was determined. Because the monitoring data was collected over a three-year period, the total was divided by three. Each county’s grade was determined using the weighted average.

The weighted averages of all counties were ranked and a frequency distribution was determined. Using this frequency distribution, each county was assigned a grade following the system used in a standard grade school setting. The top 10% of counties, with a weighted average of zero (no violations over the three year period) were given a grade of A. The next 10% of counties, with weighted averages between 0.3 and 0.9 were given a grade of B. The next 10% of counties, with a weighted average between 1.0 and 2.0 received a C grade. A grade of D was assigned to those counties with scores between 2.1 and 3.2 - the next 10% of counties. Scores of 3.3 and above (the bottom 60%) were given a grade of F. The counties were further categorized into their respective metropolitan statistical areas (MSAs) to obtain the cities with the worst and best records of ozone air pollution.

Calculations of Populations-at-Risk. Presently, state and county-specific measurements of the number
of persons with chronic and acute lung disease are not available. In order to assess the magnitude of lung disease at the state and county levels, we have utilized a synthetic estimation technique originally developed by the U.S. Bureau of the Census. This method uses age-specific national estimates of self-reported lung disease to project the prevalence and incidence of lung disease within the counties served by Lung Association constituents and affiliates.

Population Estimates. The U.S. Census Bureau estimated data on the total population of each county in the United States for 1998. The Census Bureau also estimated the age-specific breakdown of the population by county.

Prevalence Estimates: Chronic Bronchitis, Emphysema and Asthma. In 1998, the National Health Interview Survey (NHIS) estimated the nationwide annual prevalence of diagnosed chronic bronchitis at 9 million; the nationwide lifetime prevalence of emphysema was estimated at 3 million. The NHIS estimates that 10.6 million people (3.8 million under age 18) had an asthma attack or episode in 1998. 1998 represents the most recent year of publication of prevalence data for the Health Interview Survey, and so was utilized to calculate county-specific prevalence. The prevalence estimates calculated for these purposes will differ from those delineated in last year's State of the Air Report, due to the change in the Health Interview Survey questionnaire. Additionally, estimates for chronic bronchitis and emphysema should not be summed since they represent different types of prevalence estimates.

Local area prevalence of chronic bronchitis, emphysema and asthma are estimated by applying age-specific national prevalence rates from the 1998 NHIS to age-specific county-level resident populations. Prevalence estimates for chronic bronchitis and emphysema are calculated for those 18-44, 45 to 64 and 65+. The prevalence estimate for pediatric asthma is calculated for those under age 18. The prevalence estimate for adult asthma is calculated for those 18-44, 45 to 64 and 65+.

The procedure for determining local prevalence estimate is as follows. First, the age-specific county-level resident population for July 1st, 1998 is obtained from the U.S. Bureau of the Census web site. The age-specific national prevalence rate for each chronic lung disease is applied to the age-specific county-level population of each county. Thereafter, the age-specific prevalence estimates for each county within a Lung Association area are summed to determine its overall prevalence.

Limitations of Estimates. The NHIS is a scientifically designed population sample survey conducted annually by the National Center for Health Statistics. This survey serves as a source of magnitude data on chronic and acute lung disease.

Since the statistics presented by the NHIS are based on a sample, they will differ (due to random sampling variability) from figures that would be derived from a complete census, or case registry of people in the U.S. with these diseases. The results are also subject to reporting, non-response and processing errors. These types of errors are kept to a minimum by methods built into the survey. Additionally, a major limitation of the survey is that the information represents medically diagnosed conditions that may underestimate disease prevalence since we know that not all individuals with these conditions have been properly diagnosed. However, the NHIS is the best available source that depicts the magnitude of acute and chronic lung disease on the national level. The conditions covered in the survey may vary considerably in the accuracy and completeness with which they are reported.
Local estimates of chronic lung diseases are scaled in direct proportion to the base population of the county and its age distribution. No adjustments are made for other factors that may affect local prevalence (e.g., local prevalence of cigarette smokers or occupational exposures) since the health surveys that obtain such data are rarely conducted on the county level. Because the estimates do not account for geographic differences in the prevalence of chronic and acute diseases, the sum of the estimates for each of the counties in the United States may not exactly reflect the national estimate derived by the NHIS.

REFERENCES


JONATHAN M. SAMET, M.D., FRANCESCA DOMINICI, PH.D., FRANK C. CURRIERO, PH.D., IVAN COURSAC, M.S.,
AND SCOTT L. ZEGAR, PH.D.

ABSTRACT

Background Air pollution in cities has been linked to increased rates of mortality and morbidity in developed and developing countries. Although these findings have helped lead to a tightening of air-quality standards, their validity with respect to public health has been questioned.

Methods We assessed the effects of five major outdoor-air pollutants on daily mortality rates in 20 of the largest cities and metropolitan areas in the United States from 1987 to 1994. The pollutants were particulate matter that is less than 10 µm in aerodynamic diameter (PM₁₀), ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide. We used a two-stage analytic approach that pooled data from multiple locations.

Results After taking into account potential confounding by other pollutants, we found consistent evidence that the level of PM₁₀ is associated with the rate of death from all causes and from cardiovascular and respiratory illnesses. The estimated increase in the relative rate of death from all causes was 0.51 percent (95 percent posterior interval, 0.07 to 0.93 percent) for each increase in the PM₁₀ level of 10 µg per cubic meter. The estimated increase in the relative rate of death from cardiovascular and respiratory causes was 0.68 percent (95 percent posterior interval, 0.20 to 1.16 percent) for each increase in the PM₁₀ level of 10 µg per cubic meter. There was weaker evidence that increases in ozone levels increased the relative rates of death during the winter, when ozone levels are highest, but not during the winter. Levels of the other pollutants were not significantly related to the mortality rate.

Conclusions There is consistent evidence that the levels of fine particulate matter in the air are associated with the risk of death from all causes and from cardiovascular and respiratory illnesses. These findings strengthen the rationale for controlling the levels of respirable particles in outdoor air. (N Engl J Med 2000;343:1742-9.)

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STUDIES showing that current levels of air pollution in the cities of many developed and developing countries are associated with increased rates of mortality and morbidity have heightened concern that air pollution continues to pose a threat to public health.¹⁻³ The evidence suggests that small airborne particles are a toxic component of urban air pollution. Using this interpretation of the evidence as a rationale, the Environmental Protection Agency implemented a new standard for fine particulate matter.¹ The existing standard, promulgated in 1987, specified the maximal levels allowable in a 24-hour period and on an annual basis for particulate matter with an aerodynamic diameter (the diameter of a unit-density sphere that has the same settling velocity in gas as the particle of interest) that was less than 10 µm (PM₁₀). In 1997, the agency added standards for particulate matter that is less than 2.5 µm in aerodynamic diameter (PM₂.₅), since the size of such particles better corresponds to the size of particles that can penetrate to the airways and alveoli of the lung. This decision has been controversial; critics question whether the scientific evidence is strong enough to take regulatory action.¹⁻⁴ A more detailed version of our methods and findings is available elsewhere.⁵

Key findings on particulate air pollution have come from time-series analyses of the association of air-pollution levels with the number of deaths per day.³ With the exception of a few studies, such as the multi-city Air Pollution and Health: a European Approach (APHEA) project⁶ and an analysis of data from six U.S. cities,¹¹ most of these studies have been based on single locations selected without a defined sampling plan. Consequently, the generalizability of the find-
ings is uncertain, and analytic strategies have differed among studies. Citing these limitations, critics have questioned whether the findings indicate an effect of air pollution generally or of particles specifically.\textsuperscript{21,22}

To address these limitations, we combined information on the associations of levels of the five major outdoor-air pollutants — PM$_{10}$, ozone, sulfur dioxide, carbon monoxide, and nitrogen dioxide — with daily mortality rates from 20 of the largest U.S. cities.\textsuperscript{14} Our estimates are based on a defined sample of the cities; statistical precision was enhanced by combining information from multiple locations.

**METHODS**

Data Collection

Data were collected from 1987 through 1994. We began with the 20 counties deemed the largest in the 1990 U.S. Census on the basis of population (or with logical groupings of counties), and for the analysis, we used data for the counties that included the associated cities, thus encompassing a population of more than 50 million. Analysis was carried out at the county level because the county was the common coding unit for the various data sets. In this article, we refer to cities and metropolitan areas rather than counties. Daily mortality rates were obtained from the National Center for Health Statistics (Table 1). After excluding deaths from external causes (e.g., accidents, suicide, and homicide) and deaths of nonresidents, we classified the deaths according to age group (<55 years, 55 to 74 years, and ≥75 years) and cause (cardiovascular and respiratory and other).\textsuperscript{14} Data on selected demographic characteristics were obtained from the 1990 U.S. Census.\textsuperscript{14}

Hourly temperature and dew-point data were available from the EarthInfo compact-disk\textsuperscript{17} data base of the National Climatic Data Center. For analysis we used the 24-hour mean value for each day. The air-pollution data were obtained from the data base of the Aerometric Information Retrieval System,\textsuperscript{18} which is maintained by the Environmental Protection Agency. For population-oriented monitoring variables, we downloaded all available data for PM$_{10}$, ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide. For the pollutants measured on an hourly basis, we calculated the 24-hour average. If the levels of pollutants were monitored at multiple locations in a metropolitan area, we averaged the data. To avoid the potential consequences of outlying values, we excluded the highest and lowest 10 percent of values (10 percent trimmed mean) and then averaged the values for each set of monitors, after the value for each monitor had been corrected for its yearly average.

**Statistical Analysis**

We used a two-stage log-linear regression model.\textsuperscript{19-21} In the first stage, a separate log-linear regression of the daily mortality rate on air-pollution measures and other confounders was fitted to obtain estimates of the relative rate of mortality associated with the pollution variable and the degree of statistical uncertainty for each of

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<th>COUNTRIES</th>
<th>POPULATION</th>
<th>MEAN NO. OF DEATHS/ DAY</th>
<th>MEAN NO. OF DEATHS FROM CARDIOVASCULAR AND RESPIRATORY CAUSES/ DAY</th>
<th>ANNUAL INCOME $12,679</th>
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<td>Bexar</td>
<td>1,185,394</td>
<td>20.1</td>
<td>10.5</td>
<td>19.4</td>
<td>72.7</td>
</tr>
</tbody>
</table>

*The demographic information was obtained from the 1990 U.S. Census.*
the 20 cities. In the second stage, the estimates of the relative rates were combined for all cities (after adjustment for the various levels of uncertainty) to obtain an overall estimate and to assess whether city-specific characteristics modified the estimated effect of air pollution on the relative rate of death.

In the first-stage log-linear regressions, we controlled for possible confounding by longer-term trends resulting from changes in the size and characteristics of the population, health status, and health care and from shorter-term effects of seasonality and the presence or absence of influenza epidemics. To do this, we used a flexible function that took into account the variation in the mortality rate over periods of several months (a smoothing function with respect to calendar time with 7 degrees of freedom per year per city, which was allowed to differ in the three age groups). We also adjusted for the short-term effect of weather on the risk of death by including similar smoothing functions with respect to a specific day's temperature and the average temperature for the three days preceding it (6 degrees of freedom) and to dew point (5 degrees of freedom). Finally, we included indicator variables for the day of the week. This model specification was based on extensive, previously reported exploratory analyses. In this article, our results do not reflect the degree of freedom used. We have found that the relative rates of air pollution were not sensitive to the number of degrees of freedom selected for the smoothing functions of time, temperature, and dew point.

In the first-stage analysis, we analyzed the effect of the day on which the pollution data were obtained (the current day, the day before, or two days before) on the association with mortality rates. The overall effect did not vary with the lag interval selected. Consequently, we report data for a one-day lag between pollution variables and mortality.

We considered the effects of multiple pollutants on the relative rate of mortality. We initially conducted univariate analyses that included PM$_{10}$ alone and ozone alone. We then considered the effects of these pollutants in a bivariate model and developed trivariate models that also included sulfur dioxide, nitrogen dioxide, or carbon monoxide. The trivariate models provided estimates of the individual effects of carbon monoxide, sulfur dioxide, and nitrogen dioxide on the risk of death after adjustment for PM$_{10}$ and ozone levels.

The second stage of the analysis provided pooled estimates of the relative rates of mortality associated with specific pollutants and a characterization of the effects of air pollutants among the cities. We also examined factors determining heterogeneity in the effect of air pollution on mortality. With respect to determinants of heterogeneity in the second stage of the analysis, we assumed that the first-stage estimates of the relative mortality rates associated with specific pollutants followed a linear regression with the selected city-specific demographic characteristics (Table 1) as predictor variables. The second-stage analysis provided an estimate of the effect of each predictor on the relative rate of mortality associated with PM$_{10}$.

Model fitting was performed with use of a Bayesian statistical approach, which provides an estimate of the posterior distribution of the variable of interest. We carried out this analysis without making a strong prior assumption as to the value of the relative rate. The posterior distribution is used to determine the probability that the relative rate of mortality associated with PM$_{10}$ has a particular value—that is, it is a measure of the strength of the association. The key calculation is the posterior probability that the relative rate of mortality associated with PM$_{10}$ is greater than zero. The posterior distribution can also be used to determine the 95 percent posterior intervals. The 95 percent posterior interval encompasses 95 percent of the posterior distribution, a Bayesian formulation similar to the 95 percent confidence interval. All analyses were performed with use of S-Plus statistical software.

RESULTS

The 20 cities and metropolitan areas broadly represented the United States. The number of days for which pollution data were available varied (Table 2). Since the Environmental Protection Agency requires levels of PM$_{10}$ to be measured only every six days, data for ozone and other pollutants were generally available on more days. The mean daily values for PM$_{10}$ ranged from about 20 µg per cubic meter to nearly 50 µg per cubic meter; the present maximal allowable level of PM$_{10}$ in a 24-hour period is 150 µg per cubic meter. The average numbers of deaths per day were substantial, ranging from less than 20 to nearly 200 (Table 1). The correlation coefficients of all correlations between pollutants for all 20 cities and metropolitan areas are provided in Table 3. The correlation structure generally reflects the common sources of the primary combustion-related gases (sulfur dioxide, nitrogen dioxide, and carbon monoxide) and of PM$_{10}$. The level of ozone was only slightly correlated with that of PM$_{10}$ and was not correlated with the levels of other gaseous pollutants.

In initial univariate analyses, the level of PM$_{10}$ was positively associated with the rate of death from all causes in most of the 20 cities and metropolitan areas (Fig. 1). Adjustment for the effect of ozone levels had little effect on the association, whereas the effects of ozone level, before and after adjustment for PM$_{10}$ levels, tended to be more variable. The analysis of each pollutant was also stratified according to the cause of death. The city-specific associations between PM$_{10}$ levels and the rate of death from cardiovascular and respiratory causes were similar to those for the rate of death from all causes. A previous univariate analysis stratified according to age showed no age-associated trend. The combined analysis for all 20 cities and metropolitan areas confirmed the association between PM$_{10}$ levels and the rate of death from all causes (Fig. 2) and of death from cardiovascular and respiratory causes. Figure 2 shows the posterior distributions of the estimated increases in the relative rates of death from all causes associated with each increase in the PM$_{10}$ level of 10 µg per cubic meter before and after adjustment for levels of ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide, as well as the probability that overall effects are greater than zero for each model. With respect to death from all causes, the distributions are shifted toward the right, with the respective mean increases in the number of deaths per day for each increase in the PM$_{10}$ level of 10 µg per cubic meter (i.e., estimated relative rates) ranging between approximately 0.3 percent and 0.6 percent. An increase in the relative rate of 0.3 percent corresponds to a relative risk of death of 1.003. In the model that included PM$_{10}$ alone, the estimated increase in the relative rate of death from all causes was 0.51 percent for each increase in the PM$_{10}$ level of 10 µg per cubic meter (95 percent posterior interval, 0.07 to 0.93 percent). The posterior distributions of the PM$_{10}$ levels did

1744 · December 14, 2000
Table 2. Mean Levels of Pollutants in 20 U.S. Cities and Metropolitan Areas.*

<table>
<thead>
<tr>
<th>City or Metropolitan Area</th>
<th>No. of Monitors</th>
<th>NO. OF DAYS ON WHICH DATA WERE COLLECTED</th>
<th>PM&lt;sub&gt;10&lt;/sub&gt;</th>
<th>OZONE</th>
<th>PM&lt;sub&gt;10&lt;/sub&gt;</th>
<th>NITROGEN DIOXIDE</th>
<th>SULFUR DIOXIDE</th>
<th>CARBON MONOXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>7</td>
<td>2222 580</td>
<td>22.8 (6.9, 40.2)</td>
<td>46.0 (21.2, 73.1)</td>
<td>39.4 (23.2, 58.6)</td>
<td>1.9 (-0.2, 3.8)</td>
<td>15.1 (5.9, 28.3)</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>15</td>
<td>2222 489</td>
<td>19.6 (7.8, 34.0)</td>
<td>28.8 (16.1, 48.8)</td>
<td>38.9 (27.0, 53.7)</td>
<td>12.8 (4.5, 25.1)</td>
<td>20.4 (14.5, 27.6)</td>
<td></td>
</tr>
<tr>
<td>Chicago</td>
<td>16</td>
<td>2222 268</td>
<td>19.6 (6.1, 32.5)</td>
<td>35.6 (15.7, 60.3)</td>
<td>24.3 (14.4, 35.0)</td>
<td>6.4 (3.3, 10.5)</td>
<td>7.9 (4.5, 11.9)</td>
<td></td>
</tr>
<tr>
<td>Dallas-Fort Worth, Tex.</td>
<td>2</td>
<td>2222 624</td>
<td>25.3 (11.4, 41.2)</td>
<td>32.8 (11.4, 39.8)</td>
<td>13.8 (5.9, 22.7)</td>
<td>1.1 (-0.9, 4.8)</td>
<td>7.4 (4.6, 12.0)</td>
<td></td>
</tr>
<tr>
<td>Houston</td>
<td>2</td>
<td>2222 793</td>
<td>20.5 (9.3, 35.1)</td>
<td>30.0 (13.5, 48.6)</td>
<td>18.8 (9.0, 29.4)</td>
<td>2.8 (0.6, 5.6)</td>
<td>8.9 (4.0, 14.2)</td>
<td></td>
</tr>
<tr>
<td>San Diego, Calif.</td>
<td>4</td>
<td>2222 521</td>
<td>31.6 (18.1, 45.8)</td>
<td>33.6 (18.1, 52.1)</td>
<td>22.9 (11.2, 38.4)</td>
<td>1.7 (-0.3, 4.8)</td>
<td>11.0 (4.5, 20.5)</td>
<td></td>
</tr>
<tr>
<td>Santa Ana-Anaheim, Calif.</td>
<td>2</td>
<td>2222 480</td>
<td>23.0 (7.5, 35.5)</td>
<td>37.4 (18.4, 59.2)</td>
<td>35.1 (18.0, 59.0)</td>
<td>1.3 (-0.4, 4.0)</td>
<td>12.3 (5.7, 25.2)</td>
<td></td>
</tr>
<tr>
<td>Phoenix, Ariz.</td>
<td>10</td>
<td>2219 436</td>
<td>22.9 (10.3, 35.3)</td>
<td>39.7 (21.4, 58.4)</td>
<td>16.6 (8.8, 26.0)</td>
<td>6.4 (1.8, 12.4)</td>
<td>6.6 (3.2, 11.1)</td>
<td></td>
</tr>
<tr>
<td>Denver</td>
<td>1</td>
<td>1861 1368</td>
<td>22.6 (9.1, 37.5)</td>
<td>40.9 (16.4, 71.1)</td>
<td>21.3 (11.5, 32.2)</td>
<td>NA</td>
<td>10.6 (6.5, 15.9)</td>
<td></td>
</tr>
<tr>
<td>Miami</td>
<td>4</td>
<td>2882 484</td>
<td>23.0 (14.5, 40.0)</td>
<td>38.7 (16.0, 56.6)</td>
<td>13.0 (4.5, 20.2)</td>
<td>9.9 (1.7, 19.8)</td>
<td>11.8 (7.0, 17.2)</td>
<td></td>
</tr>
<tr>
<td>Philadelphia</td>
<td>8</td>
<td>2091 495</td>
<td>20.5 (3.9, 39.5)</td>
<td>38.4 (19.0, 56.0)</td>
<td>32.2 (20.7, 45.0)</td>
<td>2.6 (0.1, 5.9)</td>
<td>11.8 (7.0, 17.0)</td>
<td></td>
</tr>
<tr>
<td>Minneapolis</td>
<td>8</td>
<td>NA 2764</td>
<td>NA</td>
<td>26.9 (10.9, 45.2)</td>
<td>17.6 (8.6, 27.4)</td>
<td>NA</td>
<td>17.8 (10.5, 26.4)</td>
<td></td>
</tr>
<tr>
<td>Seattle</td>
<td>7</td>
<td>1820 2205</td>
<td>19.4 (8.7, 30.0)</td>
<td>25.3 (10.2, 44.8)</td>
<td>NA</td>
<td>NA</td>
<td>9.4 (1.7, 21.3)</td>
<td></td>
</tr>
<tr>
<td>San Jose, Calif.</td>
<td>2</td>
<td>2292 945</td>
<td>17.9 (7.7, 28.1)</td>
<td>30.4 (9.3, 61.6)</td>
<td>25.1 (11.7, 44.1)</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td>3</td>
<td>1712 1288</td>
<td>25.0 (12.7, 44.9)</td>
<td>45.1 (19.7, 87.8)</td>
<td>25.2 (15.2, 38.7)</td>
<td>10.3 (2.7, 19.9)</td>
<td>8.5 (3.7, 13.8)</td>
<td></td>
</tr>
<tr>
<td>San Bernardino, Calif.</td>
<td>8</td>
<td>2922 838</td>
<td>35.9 (14.5, 66.2)</td>
<td>37.0 (16.1, 56.2)</td>
<td>27.9 (15.4, 41.5)</td>
<td>0.7 (-0.2, 3.3)</td>
<td>10.3 (4.0, 17.5)</td>
<td></td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>20</td>
<td>2882 2899</td>
<td>20.7 (7.0, 36.6)</td>
<td>31.6 (8.9, 61.2)</td>
<td>27.6 (17.6, 86.5)</td>
<td>14.2 (4.5, 26.8)</td>
<td>12.2 (6.1, 19.8)</td>
<td></td>
</tr>
<tr>
<td>Oakland, Calif.</td>
<td>3</td>
<td>2922 508</td>
<td>17.2 (7.7, 26.9)</td>
<td>26.3 (9.3, 47.2)</td>
<td>21.2 (9.6, 35.2)</td>
<td>NA</td>
<td>9.1 (2.9, 17.0)</td>
<td></td>
</tr>
<tr>
<td>Atlanta</td>
<td>3</td>
<td>2200 482</td>
<td>24.5 (11.6, 37.4)</td>
<td>34.4 (15.8, 56.4)</td>
<td>20.4 (11.7, 30.4)</td>
<td>6.0 (4.4, 14.0)</td>
<td>8.3 (3.2, 14.3)</td>
<td></td>
</tr>
<tr>
<td>San Antonio, Tex.</td>
<td>2</td>
<td>2918 610</td>
<td>22.2 (11.4, 34.5)</td>
<td>28.8 (12.3, 36.3)</td>
<td>NA</td>
<td>NA</td>
<td>10.1 (4.1, 17.3)</td>
<td></td>
</tr>
</tbody>
</table>

*Cities are listed according to sample population size. Values shown are 10 percent trimmed means, as described in the Methods section. Values in parentheses are the 10th and 90th percentiles. PM<sub>10</sub> denotes particulate matter that is less than 10 μm in aerodynamic diameter, and NA not available.

Table 3. Correlation Coefficients of All Pairwise Correlations between Pollutants for the 20 Cities and Metropolitan Areas.*

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>PM&lt;sub&gt;10&lt;/sub&gt;</th>
<th>OZONE</th>
<th>NITROGEN DIOXIDE</th>
<th>SULFUR DIOXIDE</th>
<th>CARBON MONOXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM&lt;sub&gt;10&lt;/sub&gt;</td>
<td>1.00</td>
<td>0.25 (-0.21, 0.41)</td>
<td>0.50 (0.22, 0.74)</td>
<td>0.39 (0.16, 0.51)</td>
<td>0.48 (0.18, 0.67)</td>
</tr>
<tr>
<td>Ozone</td>
<td>1.00</td>
<td>0.02 (-0.34, 0.20)</td>
<td>-0.06 (-0.31, 0.09)</td>
<td>0.19 (-0.52, -0.04)</td>
<td>0.64 (0.51, 0.86)</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>1.00</td>
<td>0.51 (0.32, 0.70)</td>
<td>0.61 (0.30, 0.71)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>1.00</td>
<td>0.51 (0.32, 0.70)</td>
<td>0.61 (0.30, 0.71)</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

*The correlation coefficients were calculated for values for all monitors within the cities. PM<sub>10</sub> denotes particulate matter that is less than 10 μm in aerodynamic diameter.

not change substantially after adjustment for the other pollutants, suggesting that the univariate findings were not affected by confounding by other pollutants (Fig. 2).

The PM<sub>10</sub> level had a somewhat greater effect on the rate of death from cardiovascular and respiratory causes than on the rate of death from all causes and was associated with a correspondingly larger probability that the effect was greater than zero. The estimated increase in the relative rate of death from cardiovascular and respiratory causes was 0.68 percent for each increase of 10 μg per cubic meter in the PM<sub>10</sub> level (95 percent posterior interval, 0.20 to 1.16 percent).

The univariate effects of ozone levels were examined during a one-year period and according to sea-
Figure 1. Regression Coefficients for the Changes in the Rate of Death from All Causes for Each Increase in the PM$_{10}$ Level of 10 µg per Cubic Meter, before and after Adjustment for Ozone Levels, and for Each Increase in the Ozone Level of 10 ppb, before and after Adjustment for PM$_{10}$ Levels in 20 Cities and Metropolitan Areas.

PM$_{10}$ denotes particulate matter that is less than 10 µm in aerodynamic diameter. Bars indicate 95 percent confidence intervals. No data on ozone were available for Minneapolis.

ason. Overall, the posterior distributions of the effects of ozone were centered near zero, and there was only an even chance that the effect was larger than zero when death from all causes and death from cardiovascular and respiratory causes were considered separately. Because ozone levels vary strongly with the season, we compared the effects of ozone levels during the three hottest summer months (June, July, and August), when levels are highest, and three cold months (November, December, and January), when levels tend to be lowest. With the use of this stratification, the estimated relative rates of death from all
causes with each increase in the ozone level of 10 ppb were 0.41 percent (95 percent posterior interval, 
-0.20 to 1.01 percent) during the summer months and 
-1.83 percent (95 percent posterior interval, 
-2.69 to -0.96 percent) during the cold months.

The differences between cities in the relative rates
did not depend on average \( PM_{10} \) or ozone levels in
a city or on city-specific demographic characteristics;
for these variables, all associated 95 percent posterior
or intervals included zero. Consequently, the analyses
and results for \( PM_{10} \) were not adjusted for these city-specific characteristics.

We also analyzed the effects of levels of carbon
monoxide, sulfur dioxide, and nitrogen dioxide in a
fashion similar to that of the analysis of \( PM_{10} \) levels.
After adjustment for \( PM_{10} \) and ozone levels, we found
little evidence that these pollutants had a significant
effect on the relative rate of death.

DISCUSSION

We found consistent evidence that the level of \( PM_{10} \)
is associated with the rates of death from all causes
and from cardiovascular and respiratory causes. The
association of \( PM_{10} \) was not affected by the inclusion of
other pollutants in the statistical model or by the time
at which data were collected. Our findings strongly
support the findings of prior studies of particulate matter
and mortality. These studies, which were largely
based on data from single cities, used a variety of
measures of particulate matter, including levels of total
suspended particles, black smoke (a measure of soiling
of a filter that provides an index of particle levels),
\( PM_{10} \), and \( PM_{2.5} \). The statistical methods used to
assess the relations between levels of pollution and the
risk of death were also heterogeneous; for example,
there was no uniformity in the approaches used to
control for factors that varied over time or for other
pollutants. Nonetheless, using a weight-of-evidence
approach, the Environmental Protection Agency
interpreted the results of the studies as indicating a
possibly causal association between levels of particulate
matter and adverse effects on health.

In a meta-analysis of U.S. studies of particulate air
pollution published between 1990 and 1993, Dockery
and Pope estimated that each increase in the
\( PM_{10} \) level of 10 \( \mu g \) per cubic meter increased the
relative rate of death from all causes by 1 percent. In
a subsequent update that included data from reports
published through 1995, Dockery and Pope found
little change in this estimate. Schwartz also
performed a meta-analysis of studies published between
1990 and 1993 but included data from London and
Minneapolis. In addition to the data on the eight citi-
cities considered by Dockery and Pope. The resulting
estimated increase in the relative rate of death from
all causes was 0.7 percent for each increase in the
\( PM_{10} \) level of 10 \( \mu g \) per cubic meter. The APHEA
project analyzed data from 12 European cities and
then estimated summary measures. For the six west-
er European cities in the study, the mortality rate
was estimated to increase by 0.4 percent for each in-
crease in the \( PM_{10} \) level of 10 \( \mu g \) per cubic meter. In
our 20-city analysis, our estimate of an increase of
approximately 0.5 percent in the rate of death from
all causes for each increase in the \( PM_{10} \) level of 10 \( \mu g 
\) per cubic meter is very similar to the estimate of the
APHEA project. The fact that our estimate was lower
than those of Dockery and Pope and Schwartz may
reflect differences in analytic techniques and the
cities selected. The initial reports included in the meta-
analyses may have been biased by the fact that studies
with positive findings are more likely to be select-
ed for publication than those with negative findings.
Our 20-city estimate is not subject to such bias and
our results should thus be more applicable to the
United States in general.

We did not find an effect of ozone levels on the
overall rate of death from all causes or from cardio-
vascular and respiratory causes during the full year
period. Ozone levels were positively associated with mor-
tality rates during the summer months when ozone
levels were highest, although the 95 percent poste-

001482
rior interval extended into the range indicating no effect of ozone levels on mortality. The finding of an effect of ozone levels only during the summer may reflect the higher levels of ozone during these months or, possibly, differences in the characteristics of photochemical pollution during the various seasons. Other recent studies have generally found an association between ozone levels and the risk of death. In the APHEA project, the maximal ozone levels during a one-hour period were associated with the numbers of deaths per day in four cities (London; Athens, Greece; Barcelona, Spain; and Paris), and a quantitatively similar effect was found with additional data from three cities (Amsterdam; and Basel and Zurich, Switzerland) that were not part of the APHEA project. For each increase of 50 μg per cubic meter in the one-hour maximal level, the estimated relative risk of death was 1.029 (i.e., a 1.1 percent increase in the rate of death for each increase in the ozone level of 10 ppb), with the use of a random-effects model for combining the city-specific data. Thurston and Ito pooled data from 15 studies and estimated that the relative risk of death was 1.036 for each increase of 100 ppb in the daily one-hour maximal level of ozone (i.e., a 0.36 percent increase in the rate of death for each increase in the ozone level of 10 ppb). For the summer months, our estimate (a 0.41 percent increase in the rate of death for each increase in the ozone level of 10 ppb) was similar to those of Thurston and Ito. Taken together, the results of these three studies provide consistent evidence that exposure to ozone also increases the risk of death.

The limitations of our analyses should be considered. Data on levels of PM_{2.5} are not yet available nationally, since a monitoring network for particles in this size range is currently being implemented. We used PM_{10} levels because they have been monitored since 1987; there is variation across the United States in the proportion of PM_{10} mass that is made up of PM_{2.5}, so that the PM_{10} level is an imperfect surrogate for the PM_{2.5} level. In addition, for regulatory purposes, PM_{10} levels must only be measured every six days, limiting the extent of available data.

Our analyses also did not address the extent to which life is shortened in association with daily exposure to the various pollutants. The finding that the association between PM_{10} levels and the risk of death was strongest for cardiovascular and respiratory causes of death is consistent with the hypothesis that persons made frail by advanced heart and lung disease are more susceptible to the adverse effects of air pollution. The findings from several epidemiologic studies of the longer-term effects of air pollution on the risk of death suggest that exposure to air pollution may do more than simply shorten life by a few days. Several analyses of daily mortality data also indicate that the effect of air pollution may go beyond shortening life by a few days.

We found no evidence that key socioeconomic factors such as low socioeconomic status affect the association between PM_{10} levels and the risk of death in linear regression models. The medical conditions and poor health that increase the risk of death may not be adequately reflected by the socioeconomic indicators recorded by the U.S. Census. Thus, more specific information on health status, rather than on social factors, may be needed to explore this issue, particularly in relation to the susceptibility of particular groups of people. Finally, we used county-level data for these social factors because most of our data were categorized according to county. The variation in socioeconomic status in a typical urban county, however, is usually considerably larger than the variation among counties. Thus, the demographic factors considered in the second stages of the models may be too broad to be informative.

The epidemiologic evidence that levels of particulate matter are associated with the risk of mortality and morbidity has prompted the promulgation of a new standard for PM_{10} in the United States and a rethinking of guidelines for particulate matter in Europe. Our analyses provide evidence that particulate air pollution continues to have an adverse effect on the public’s health and strengthen the rationale for limiting levels of respirable particles in outdoor air.
SELECTED KEY STUDIES ON
PARTICULATE MATTER AND HEALTH: 1997 - 2001

NEW STUDIES CONFIRM THAT CURRENT LEVELS OF
PARTICULATE AIR POLLUTION ARE HARMFUL TO HUMAN
HEALTH

The Clean Air Act requires the U.S. Environmental Protection Agency (EPA) to review and update the National Ambient Air Quality Standards for major air pollutants every five years, in light of the latest scientific evidence.

More than 800 new scientific studies related to the effect of airborne particulates on human health have been published since 1996, when EPA last reviewed the standards for particulate matter. The new studies validate the earlier research and address the most important arguments raised by industry critics. Taken together, the studies confirm the relationship between particulate air pollution, illness, hospitalization, and premature death. The major themes of the new research are that the:

- Major long-term studies have been fully validated.
- New short-term studies from across the U.S. and around the world confirm the mortality effects.
- New analyses show that lives may be shortened by months or years, rather than days.
- Recent studies of laboratory animals and humans have identified cardiac responses to particles, thus elucidating possible biologic mechanisms for mortality.
- New studies demonstrate that infants and children, particularly asthmatic children, are especially sensitive to the effects of fine particle pollution.

In 1997 when EPA announced the establishment of new NAAQS for fine particles, the President directed EPA to complete a review of the standards by July 2002.

The National Academy of Sciences (NAS) has issued several reports recommending research priorities to increase scientific understanding of particle pollution. To address the scientific issues raised by the NAS panel, EPA increased funding for research on particulates to more than $50 million per year.
NEW STUDIES CONFIRM THAT CURRENT LEVELS OF PARTICULATE AIR POLLUTION ARE HARMFUL TO HUMAN HEALTH

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- Recent studies of laboratory animals and humans have identified cardiac responses to particles, thus elucidating possible biologic mechanisms for mortality.
- New studies demonstrate that infants and children, particularly asthmatic children, are especially sensitive to the effects of fine particle pollution.

In 1997 when EPA announced the establishment of new NAAQS for fine particles, the President directed EPA to complete a review of the standards by July 2002.

The National Academy of Sciences (NAS) has issued several reports recommending research priorities to increase scientific understanding of particle pollution. To address the scientific issues raised by the NAS panel, EPA increased funding for research on particulates to more than $50 million per year.
As part of this effort, the Health Effects Institute, jointly sponsored by industry and EPA, has committed substantial resources to research on PM.

As a result of this infusion of research funds, hundreds of scientific papers and research reports have been published since EPA last issued its “Air Quality Criteria for Particulate Matter” in 1996.

This annotated bibliography presents the findings of some of the most significant new research studies that advance our understanding of the harmful health effects of particulate air pollution. The peer-reviewed papers cited here represent a small sample of the scientific articles on the health effects of particulate air pollution published since 1996. This bibliography does not attempt to be comprehensive; exclusion does not imply that a study is unimportant; inclusion does not imply endorsement.

LONG-TERM STUDIES OF MORTALITY

Prospcetive Cohort Epidemiological Studies Are Validated in Independent Reanalysis

Two landmark prospective cohort studies reported that chronic exposure to particulate pollution increases the risk of premature mortality. In the 1993 Six Cities Study, Harvard University researchers followed the health of more than 8,000 people in six small cities that fell along a gradient of air pollution concentrations for a period of 14 to 16 years. As particle concentrations increased, there was an almost directly proportional increase in the death rate in the residents studied. Residents of the most polluted city in the study, Steubenville, Ohio, had a 26 percent increased risk of premature mortality, compared to the residents of the cleanest city studied, Portage, Wisconsin. The increased risks were associated with a difference in ambient fine particle concentrations of 18.6 micrograms per cubic meter.

The 1995 American Cancer Society study reported an association between fine particle air pollution and premature death by cardio-pulmonary and other causes in a study group of over half a million people in 151 U.S. cities. All cause mortality increased by 17 percent with a 24.5 microgram per cubic meter difference in fine particle pollution between the cleanest and dirtiest city studied.

These original studies used statistical techniques to adjust for age, and to control for the effects of smoking, diet, and occupational exposure.

Health Effects Institute funded researchers, led by Dr. Dan Krewski of the University of Ottawa, undertook a reanalysis of the original studies and a quality audit of the underlying data. Researchers performed an extensive sensitivity analysis using alternative statistical methods, and considering the role of 20 potential confounders such as other pollutants, climate, and socio-economic factors on study results. The sensitivity analysis largely confirmed the original results of the Harvard Six Cities Study and the American Cancer
Society Study. In addition, the sensitivity analysis identified higher educational status as a factor associated with reduced risk to air pollution exposure, and reported an association between sulfur dioxide pollution and mortality.


Chronic Exposure to Particulate Pollution Shortens Lives by One to Three Years

There have been two recent attempts to quantify the extent of life shortening predicted by the long-term epidemiological studies. Dutch scientist Dr. Burt Brunekreef made such an estimate in a paper prepared for the World Health Organization's consideration of revisions to the Air Quality Guidelines for Europe. Using risk ratios reported in the Harvard Six Cities Study and the Study of the American Cancer Society cohort, Brunekreef conducted a life table analysis to estimate the effect of particulate air pollution on the survival rate of 25 year-old Dutch men. An extrapolation based on U.S. life tables yields an estimated diminished life expectancy of 1.31 years due to ambient pollution.

Dr. C. Arden Pope III, of Brigham Young University, analyzed reductions in life expectancy in the U.S. population due to chronic exposure to particulate matter. He applied relative risks for premature death derived from the prospective cohort studies, and estimated loss of life expectancy ranging from one to three years, depending upon assumptions about the age at which susceptibility to the effects of air pollution begins.


DAILY MORTALITY STUDIES

90-City National Morbidity, Mortality and Air Pollution Study (NMMAPS) Shows that Contemporary Levels of Air Pollution are Killing People

The Health Effects Institute, which is jointly funded by EPA and industry, commissioned an original nationwide study of the short-term effects of air pollution on human health, known as the National Morbidity, Mortality and Air Pollution Study, or NMMAPS. A
team of investigators led by Dr. Jonathan Samet of the Johns Hopkins University School of Public Health developed and applied a standardized methodology for examining pollution effects across many cities. Investigators from Johns Hopkins University and Harvard University developed and applied state-of-the-art statistical techniques to examine the effects of multiple pollutants, the extent of life-shortening, and the degree of "exposure measurement error" due to reliance on centrally located air quality monitors.

In its study of the 90 largest U.S. cities, NMMAPS found strong evidence linking daily increases in particulate pollution to increases in death. On average, overall mortality increased by 0.5 percent for every 10 microgram per cubic meter increase in PM$_{10}$ measured the day before death. The effect was slightly greater for deaths due to heart and lung disease than for total deaths. This risk ratio is somewhat lower than reported by earlier meta-analyses, perhaps due to certain methodological assumptions such as a one-day lag.

Samet et al. report that the relative increases in daily mortality partly reflect life shortening on the order of months. The association between particulate matter and mortality persists even when other pollutants are included in the statistical model. Their analyses also provide evidence against arguments that exposure measurement error could explain the associations between particulate matter and adverse health effects.

In addition, in a study of 14 U.S. cities, NMMAPS found strong and consistent associations between particulate air pollution and hospital admissions among the elderly. Hospital admissions data was obtained from the Medicare program. The cities were selected for study because they had daily PM$_{10}$ measurements.

For each 10 microgram per cubic meter increase in PM$_{10}$, there was approximately a 1 percent increase in hospital admissions for cardiovascular disease, and about a 2 percent increase in admissions for pneumonia and chronic obstructive pulmonary disease. Cities studied were Birmingham, AL, Boulder, CO, Canton, OH, Chicago, IL, Colorado Springs, CO, Detroit, MI, Minneapolis/St. Paul, MN, Nashville, TN, New Haven, CT, Pittsburgh, PA, Provo/Orem, UT, Seattle, WA, Spokane, WA, and Youngstown, OH.

Investigators concluded that the complementary analyses of mortality and morbidity provide "new and strong evidence" linking particulate air pollution at current levels to adverse health effects.

Some of the results from the NMMAPS study were published in an article in the New England Journal of Medicine. Samet, et al. examined the effect of five of the most widespread outdoor air pollutants — particulate matter, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide in 20 of the largest cities in the United States. The study was specifically designed to address many of the criticisms of earlier single-city studies. The study found consistent evidence that relatively small daily increases in particulate pollution were followed by daily increases in death rates, particularly from heart- and lung-related causes. Study authors noted that other analyses have demonstrated that the
amount of life lost due to particulate pollution goes beyond just a few days. The study investigators also reported an association between summertime ozone levels and mortality.

The New England Journal of Medicine article concludes, "there is consistent evidence that the levels of fine particulate matter in the air are associated with the risk of death from all causes and from cardiovascular and respiratory illness. These findings strengthen the rationale for controlling the levels of respirable particles in outdoor air."


Air Pollution Effects Persist for Several Days, Increasing the Overall Risk of Exposure

Epidemiological studies have used different assumptions about the number of days following exposure to air pollution that effects will occur. Some studies have assumed that effects occur the day after exposures. However, toxicological evidence suggests that effects of exposure may be observed over several subsequent days. In an analysis using data from New Haven, Birmingham, Pittsburgh, Canton, Detroit, Chicago, Minneapolis, Colorado Springs, Spokane, and Seattle, Dr. Joel Schwartz, of the Harvard School of Public Health, has shown that statistical models that assume a one day lag, such as NMMAPS, grossly underestimate the effect of PM$_{10}$ on mortality. Assuming that effects continue over several days, as demonstrated by this analysis, roughly doubles the relative risk of premature mortality.


PM$_{2.5}$ from Motor Vehicles and Coal Combustion is Linked to Increased Mortality

Investigators from Harvard Medical School used data on the elemental composition of size-fractionated particles to identify the sources of fine particles in six eastern U.S. cities that have been the subject of a long-term air pollution study: Watertown, MA, Kingston-Harriman, TN, St. Louis, MO, Steubenville, OH, Portage, WI, and Topeka, KS. For example, lead was used as a tracer for motor vehicle exhaust, selenium for coal combustion, and silicon for soil and crustal matter. Each of these fractions was examined in association with daily mortality rates in each city. The study reported that a
10 μg/m³ increase in PM$_{2.5}$ from mobile sources accounted for a 3.4% increase in daily mortality, while the equivalent increase in fine particles from coal combustion sources accounted for a 1.1% increase. Fine particles from crustal sources were not associated with mortality. The study concludes that "the results indicate that combustion particles in the fine fraction from mobile and coal combustion sources, but not fine crustal particles, are associated with increased mortality."


**Daily Mortality Studies Pour In From Cities Around the World**

Studies in new locations and by additional investigators with consistent results help strengthen the case for a causal relationship.

EPA’s 1996 review of the PM standards cited over two dozen short-term epidemiological studies. Since then, time series studies reporting an association between short-term exposure to particulate matter and early mortality have been published for these U.S. cities: Philadelphia; Ogden, Salt Lake City, and Provo/Orem, Utah; Seattle; Santa Clara County, California; and Buffalo. Additional studies have been published for these major cities all over the world: Toronto; Mexico City; London; Edinburgh; Birmingham, UK; Rotterdam; Helsinki; Madrid; Rome; Milan; Brisbane; Sydney; Delhi; Bangkok; and Seoul and Ulsan, Korea. Many of the new studies have evaluated the sensitivity of the estimated PM effects to the inclusion of other pollutants in the statistical model. Overall, the associations of PM with adverse effects continue to be consistently observed, and sometimes, effects of other air pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide are also reported.

A multi-city study of the short-term health effects of air pollution on mortality and hospital emergency admissions was initiated by the European Union Environment Programme. The study, known as Air Pollution and Health: A European Approach or APHEA, investigated the effects of several pollutants on mortality in 12 European cities. The study reported positive associations with sulfur dioxide and PM$_{10}$, and daily increases in mortality, with stronger and more consistent associations observed in western European cities.

A quantitative meta-analysis by Jonathan Levy et al. of the Harvard School of Public Health set out to compare mortality estimates from over twenty daily time series studies. Their analysis estimated that mortality rates increased by approximately 0.7 percent per 10 microgram per cubic meter increase in PM$_{10}$ concentrations. Investigators reported "our model finds compelling evidence that the PM$_{10}$-mortality relationship is stronger in locations with higher PM$_{2.5}$/PM$_{10}$ ratios, supporting the hypothesized role of fine particles."

001492
"HARVESTING" THEORY DISPROVEN

Mortality Reported in Short Term Community Health Studies is Not Due to "Harvesting"

Numerous short-term epidemiological studies have reported that short-term increases in air pollution are followed by an increased number of deaths. Some have argued that the associations between day to day variations in mortality and air pollution represent a "harvesting" effect, that is, the advancement of death by a few days in people already about to die from other causes. If air pollution advances death of the very frail by only a few days (the "harvesting" hypothesis), then you would expect that an increase in daily deaths would be followed by a decrease in deaths within a few days.

Professors Scott Zeger and Francesca Dominici of the Johns Hopkins School of Public Health developed a statistical technique to examine harvesting using data on total suspended particulate matter (TSP) and total mortality in Philadelphia. They found that removing the shortest term fluctuations from their time series increased rather than decreased the estimates of pollution effects. This is the opposite of what would be expected if "harvesting" accounted for all the deaths.

As part of the NMMAIPS study, Dr. Joel Schwartz of the Harvard School of Public Health studied this issue using data from Boston. He reported that for chronic obstructive pulmonary disease and ischemic heart disease, most of the deaths seem to be advanced by a few months on average. The statistical approach did not allow estimates of life shortening beyond two months. In contrast, for pneumonia, the analysis showed that some deaths are brought forward by a few days, consistent with the harvesting hypothesis. Effect estimates increased when examining longer time periods, suggesting that cumulative exposures are more harmful than daily exposures. Overall, these results suggest that the short-term epidemiological studies underestimate the number of early deaths.


Most Air Pollution Related Deaths Are Being Advanced By Months to Years

While the association between particulate air pollution and mortality is generally acknowledged to be causal, critics have claimed that the public health impact is minor, because people are dying just a few days early. This theory is sometimes called "harvesting." This study is based on an examination of daily deaths and hospital admissions in Chicago for the years 1988-1993. If people are dying a few days early, then the death rate should drop a few days after the air pollution event. The analysis shows that this is not the case. The results confirm findings previously reported for Boston and Philadelphia, using a different methodology. The author concludes that the results indicate that air pollution may be increasing the overall number of people at risk of death, and that most of the deaths are being advanced by months to years.


PM-MORTALITY RELATIONSHIP IS LINEAR, WITH NO THRESHOLDS

No Threshold is Evident for the Effect of PM$_{10}$ on Daily Deaths

In the Schwartz and Zanobetti study, Harvard University researchers applied a statistical method to examine the shape of the dose-response relationship between air pollution and daily deaths in ten U.S. cities. The cities studied were New Haven, Birmingham, AL, Pittsburgh, Detroit, Canton, OH, Chicago, Minneapolis-St. Paul, Colorado Springs, Spokane, and Seattle. Simulation studies demonstrated that the method used can detect threshold and other nonlinear relationships in epidemiologic studies. But when used to analyze the association between PM$_{10}$ and mortality, no evidence of a threshold was found, and the associations appeared to be linear down to the lowest levels studied. This is consistent with earlier results.

An analysis of data for the 20 largest U.S. cities from 1987-1994 from the NMMAPS study also reported that a linear model, without a threshold, was most appropriate for assessing the effects of particulate air pollution on daily mortality for total mortality and for mortality from cardiovascular and respiratory causes, but not for other causes of mortality. Daniels et al conclude: "...the continued demonstration of adverse effects of air pollution over recent decades, even as concentrations of pollutants have declined, suggests that exposures have not yet gone below no-effects thresholds, if such exist."


EXPOSURE MEASUREMENT ERROR CRITICISM REFUTED

Air Quality Monitors Can Be Used to Track Exposure to Fine Particles

Epidemiological studies generally rely on centrally located air quality monitors to assess exposure to ambient air pollutants. Some have argued that these monitors do not represent actual exposures, because people spend a large portion of their day indoors.

A study by Dutch scientist Nicole Janssen et al., of 10 – 12 year old school children in Wageningen, The Netherlands compared personal exposure to fine particles with classroom concentrations, and with ambient measurements at an outdoor location. Researchers found that personal fine particle concentrations were highly correlated with ambient concentrations. This finding supports the use of ambient monitoring measurements as an indicator of exposure to fine particles in epidemiological time series studies.

Dr. David Mage, of U.S. EPA’s Office of Research and Development, and colleagues, demonstrated that human exposure to fine particles of ambient origin is highly correlated in time to ambient PM concentrations measured at monitoring stations within the communities being studied.

The NMMAPS study discussed above also addressed the issue of measurement error, through the development of a model to systematically test what effect the relationship between personal exposure and ambient exposure might have on the observed increase in mortality associated with PM. While data to test the model is limited, “theoretical and actual analyses generated appear to refute the criticisms that exposure measurement error could explain the associations between PM and adverse health effects.”


Criteria for Asserting Causality Have Been Met

In responding to an article by Dr. John Gamble, Epidemiologist for Exxon Biomedical Sciences, Dr. David Bates, Professor Emeritus of Medicine at University of British Columbia, has re-evaluated the recent evidence health evidence regarding particulate matter and mortality. Determination of causality does not rest on any one study. Instead,
a weight of evidence approach is used to evaluate the scientific literature across a series of criteria such as coherence, consistency, strength of association, temporality, analogy, and biologic plausibility. Dr. Bates asserts that all of these criteria have been met by an avalanche of new data that strengthen the case for a causal relationship.


Kunzli, N. and Tager, I.B. Comments on “PM$_{2.5}$ and Mortality in Long-term Prospective Cohort Studies: Cause-Effect or Statistical Associations?” and Gamble, John. Reply to Kunzli and Tager Regarding Causality in PM$_{2.5}$ Cohort Studies. Environ Health Perspect 107-5, 1999; Correspondence.

People With Pre-Existing Cardiac or Respiratory Conditions Have Higher Than Average Risk of Death from Exposure to Particles

Canada’s national health insurance system enables access to detailed health records of patients. This permitted Dr. Mark Goldberg and colleagues at McGill University to conduct a detailed analysis of particle pollution and mortality in Montreal. Investigators were able to link individual deaths in Montreal to medical information up to five years before death. These data were used in conjunction with clinical expertise to define susceptible subgroups at risk of premature death from several different measures of particulate pollution. Subjects with acute lower respiratory disease, congestive heart failure, and a combination of cardiovascular diseases died at higher rates for increases in each of the three particulate matter measures. Associations with coefficient of haze and predicted PM$_{2.5}$ were reported for subjects with cancer, chronic coronary artery disease, and coronary artery disease, while effects of sulfate were associated with acute and chronic upper respiratory disease.


“Coarse” Particles are Also Linked with Disease and Death

This study by Dr. Morton Lippmann and colleagues from the New York University School of Medicine attempted to identify components of particulate matter and other air pollution mixtures that were associated with excess daily deaths and hospital admissions of the elderly in the Detroit metropolitan area. Investigators reported that deaths from respiratory diseases were associated with PM$_{10}$ and total suspended particulates. Unexpectedly, they found that relative risks for PM$_{10.2.5}$, the coarse particle fraction, were similar to those for PM$_{2.5}$, and even higher in the case of ischemic heart disease and stroke. The authors conclude that “the finding of elevated and significant effects for
PM_{10,2.5} suggests that there may still be a rationale to consider the health effects of the coarse fraction as well as the fine fraction of PM.”


BIOLGIC MECHANISMS AND CARDIAC EFFECTS

Air Pollution Tied to Low Heart Rate Variability, a Risk Factor for Heart Attacks

Particulate air pollution has been linked to cardiovascular mortality in a number of studies, but the mechanisms for this effect are not well understood. Recent research centers on the effect of pollution on heart rate and heart rate variability. Low heart rate variability is a marker of poor cardiac control by the autonomic nervous system, and is associated with a higher risk of heart attacks and sudden cardiac death. One hypothesis is that inhalation of particle air pollution may trigger an inflammatory response in the lung, followed by the release of chemical mediators that affect autonomic nervous system control of the heart beat.

Pope, et al. measured oxygen saturation and pulse rate in a panel of 90 elderly residents of the Utah Valley, using a small medical device known as an oximeter. The experiment was conducted during the winter months, when PM concentrations are highest. Researchers found little evidence of pollution effects on the oxygen carrying capacity of the blood, but observed that a small elevation in pulse rate was associated with a rise in PM_{10} levels. The medical and biological relevance of this effect is unclear.

Dr. Duaping Liao, of the University of North Carolina, and co-investigators, conducted daily electrocardiogram measurements on elderly nursing home residents outside Baltimore, Maryland. Harvard physician Dr. Diane Gold et al. studied 53- to 87- year old active residents of Boston. 25 minutes of electrocardiogram measurements during different exercise states were taken on a weekly basis. Both the Baltimore and Boston studies found that elevated concentrations of fine particulate matter were associated with lower heart rate variability, and that the association was stronger for people with pre-existing cardiovascular conditions.


Increased Heart Rate and Plasma Viscosity During an Air Pollution Episode Suggest Possible Mechanisms

The World Health Organization Monitoring Survey of Trends and Determinants in Cardiovascular Disease (the "MONICA" survey) took place in Augsburg, in Southern Germany during the winter of 1984-1985. Over 4,000 randomly selected adults participated, and received electrocardiograms to measure their resting heart rate, and donated blood samples to measure plasma viscosity. Electrocardiograms were administered again in 1987-1988.

In January 1985, an air pollution episode occurred throughout central Europe, with elevated concentrations of sulfur dioxide, total suspended particulates, and carbon monoxide. During the air pollution episode, higher heart rates were observed for men and women, after adjusting for cardiovascular risk factors and weather. An elevated resting heart rate is a risk factor for death and fatal heart disease, and may signal changes in the autonomic control of the heart, that might partially account for the adverse health effects observed in association with air pollution.

One hypothesis is that increased plasma viscosity might lead to constricted blood flow in the heart (ischemia), which can be fatal in people with severe coronary heart disease. During the air pollution episode, increases in plasma viscosity were observed, and persisted after adjusting for other cardiovascular risk factors and weather. German researcher Annette Peters, et al. conclude that "the increased plasma viscosity observed in these analyses of a cross-sectional survey might therefore represent a part of the pathophysiological chain linking high ambient air pollution to increased mortality and hospital admissions for cardiovascular diseases."

An alternate hypothesis is proposed by Professor Anthony Seaton of the University of Aberdeen Medical School. He collected blood samples from 112 elderly people in two cities in the U.K. over an 18-month period, and examined various blood values in comparison to $\text{PM}_{10}$ concentrations. Based on the analysis, Seaton suggests that inhalation of some component of $\text{PM}_{10}$ may cause sequestration of red blood cells, which may explain the cardiovascular effects reported in other studies.


Heart Patients Vulnerability to Potentially Fatal Arrhythmias Increases After Exposure to Air Pollution
A pilot study was designed to test the hypothesis that heart patients with a history of serious arrhythmia requiring implanted cardiac defibrillators experience potentially life-threatening arrhythmias following short term increases in air pollution. Defibrillators monitor electrical activity of the heart and initiate interventions such as pacing or shock therapy to restore a normal heartbeat. The devices record information on arrhythmic events.

One hundred heart patients in eastern Massachusetts were followed for a three-year period. The study found that a subgroup of these patients -- those with more than ten defibrillator events -- were most susceptible to pollution, with effects occurring one to two days after exposure. Among these patients, the strongest associations were with nitrogen dioxide, but positive associations were reported for PM$_{10}$ and PM$_{2.5}$ exposures as well.


**Combustion Source Metals May Trigger Biologic Responses to Ambient Particulate Matter**

Researchers have been trying to determine whether one component of particulate matter -- such as metals -- is responsible for the toxic effects. U.S. EPA investigators led by Dr. Daniel Costa obtained samples of particulate matter from oil and coal fly ash and ambient air from St. Louis, MO, Washington, DC, Dusseldorf, Germany, and Ottawa, Canada. The fly ash is rich in metal components such as iron, copper, nickel, vanadium, and zinc, as well as sulfate. Laboratory rats were instilled with PM samples from these sources, and lung cells were obtained via bronchoalveolar lavage and analyzed for signs of cell injury. Investigators found that the constituent metals and their bioavailability determine the acute inflammatory response of PM samples in lung tissue.

In a second experiment, rats were pretreated with a chemical intended to model certain disease conditions, namely inflammation of blood vessels and high blood pressure in the lungs. These animals were instilled with the fly ash samples, and lung cells were obtained for laboratory examination. After 96 hours of exposure, there was clear evidence of lung inflammation, however many of the test animals had died, apparently due to altered cardiac function. Survivors had increased electrocardiographic changes. Investigators hypothesize that soluble metals from PM mediate an array of injuries to the cardiopulmonary system of healthy and at-risk subjects.


**Laboratory Research on Dogs Suggests that PM May Harm People with Heart Disease**
This toxicology study by Harvard pathologist Dr. John Godleski is one of the first to test whether exposure to particulate matter can change heart function in laboratory animals. Two groups of dogs were tested – healthy dogs, and dogs with an induced coronary occlusion intended to simulate human coronary artery disease. Researchers exposed dogs to concentrated particles from the ambient Boston air. Both the normal and the compromised animals showed effects, but the clearest sign of PM effects was found in the dogs with the induced heart condition. The occluded animals were more susceptible to serious arrhythmias when exposed to air pollution. The electrocardiogram signals for these dogs indicated more rapid development of ischemia, an inadequate flow of blood through the heart that can lead to a heart attack. Study reviewers concluded: “this is a plausible and important mechanism to explain the association of increased cardiopulmonary mortality and exposure to particle pollution.”


Concentrated Air Particles Induce Pulmonary Inflammation and Blood Changes in Humans

Effects of particles are showing up not only in laboratory animals, but also in a chamber study with human subjects performed by EPA research physician Dr. Andrew Chio and colleagues. This controlled exposure study of young, healthy volunteers examined the effect of exposure to concentrated ambient particles from Chapel Hill, North Carolina. Volunteers alternated between moderate exercise and rest over a two-hour period in a chamber with high particle concentrations. No symptoms or decrements in pulmonary function were noted. However, eighteen hours after exposure, lung tissue had a higher concentration of neutrophils, a marker of inflammation. Blood work indicated a higher concentration of fibrinogen, which is a risk factor for clotting and heart attacks.

Chio, A.J., Kim, C., and Devin, R.B. Concentrated Ambient Air Particles Induce Mild Pulmonary Inflammation in Healthy Human Volunteers. In Press.

HOSPITAL AND EMERGENCY ROOM VISITS

Air Pollution May Account for Five Percent of Cardiac Hospital Admissions

Numerous studies have focused on mortality because it is an easy to measure effect for which data is readily available. It is important to note that early deaths represent just the tip of the iceberg of particulate related health effects. For each death, there are many more people admitted to the hospital, and for each hospital admission, many more visits to emergency departments and doctors offices. Similarly, for each patient who visits an emergency clinic, many more experience uncomfortable respiratory symptoms or days when they must restrict their activity, increase their use of medication, or remain indoors.
Increased hospital admission rates represent one of the most serious effects of air pollution. This study examined the association between PM$_{10}$, carbon monoxide, and hospital admissions of the elderly for heart disease across eight urban counties with different pollution and weather profiles. The eight locations are: Chicago; Colorado Springs; New Haven; Minneapolis; St. Paul; Seattle; Spokane; and Tacoma. The study design was intended to minimize confounding by weather or other pollutants. Associations of both PM$_{10}$ and CO with cardiovascular hospital admissions were observed in areas with widely varying correlations between these pollutants and weather factors or other air pollutants. Overall, the results suggest that air pollution may be responsible for five percent of hospital admissions for heart disease, representing an enormous public health impact.


Emergency Room Visits for the Respiratory Illness in the Elderly Linked to Air Pollution

Consistent with reports of aggravated symptoms in those with chronic respiratory conditions, a study in Montreal, Canada found strong associations between air pollution and emergency room visits for patients over 64 years of age during 1993, when more data were available. Positive associations were reported for ozone, PM$_{10}$, PM$_{2.5}$, and sulfate, at air pollution levels well below the U.S. air quality standards. The elderly are especially susceptible to the effects of air pollution.

The NMMAPS study, discussed above, reported strong and consistent associations between particulate air pollution and hospital admissions among the elderly for cardiovascular disease, pneumonia, and chronic obstructive pulmonary disease.


Pre-Existing Cardiovascular Disease Increases the Risk of PM-Related Hospital Admissions for Respiratory Causes

This ten-year study of Medicare patients in Chicago was designed to identify subgroups that are especially susceptible to particulate pollutions. Researchers examined records of previous hospital admissions and secondary diagnoses to determine wither people with certain conditions were predisposed to having a greater risk from air pollution.

Investigators found that people with asthma had double the risk of a PM$_{10}$-associated hospital admission, and that people with heart failure had double the risk a PM$_{10}$-induced COPD admission. The authors conclude, "the results suggest that patients with acute respiratory infections or defects in the electrical control of the heart are a risk group for particulate matter effects."
INFANT MORTALITY AND EFFECTS ON CHILDREN

Growth in Children’s Lung Function is Slowed by Air Pollution

Researchers with the Children’s Health Study led by the University of Southern California have monitored levels of major air pollutants in a dozen southern California communities since 1993, while tracking the respiratory health of more than 3,000 school age children. The twelve communities, which fell along a gradient of air pollution levels, were all within a 200-mile radius of Los Angeles. The California towns studied were Alpine, Atascadero, Lake Arrowhead, Lake Elsinore, Lancaster, Lompoc, Long Beach, Mira Loma, Riverside, San Dimas, Santa Maria, and Upland. In fourth-graders, significant deficits in growth of lung function were associated with various measures of fine particles (PM₁₀, PM₂.₅, and PM₁₀₂.₅), nitrogen dioxide, and inorganic acid vapor, but not with ozone. The deficits were larger for children that spent more time outdoors. “This is the best evidence yet of a chronic effect of air pollution in children,” said Dr. John Peters, University of Southern California professor of preventative medicine and one of the study authors. The study concluded that “the results suggest that exposure to air pollution may lead to a reduction in maximal attained lung function, which occurs early in adult life, and ultimately to increased risk of chronic respiratory illness in adulthood.”


Doctor Visits Climb In Relation to Air Pollution

In Paris, France, doctors still make house calls, and public records on the reason for the visits are available through the French national health insurance program. This enabled investigators to examine a significant but understudied health endpoint, doctor visits, that affects a much larger number of patients than those admitted to hospitals or treated in emergency departments of hospitals. The statistical model of daily air pollution effects used in this study controlled for season, pollen counts, influenza epidemics and weather. Medina et al. report that house calls for asthma for children 0-14 years old showed the strongest association with air pollution.

Air Pollution May Contribute to Infant Mortality

A small but growing body of literature suggests that air pollution may contribute to infant mortality. British scientists Bobak and Leon analyzed infant mortality and several measures of long-term exposure to air pollutants in highly polluted regions of the Czech Republic. They found a consistent, positive association between PM$_{10}$ levels and post neonatal infant mortality from respiratory causes, after controlling for socioeconomic factors and other pollutants.

Dr. Dana Loomis, of the University of North Carolina, and co-workers found that air pollution is associated with acute increases in infant mortality in Mexico City after controlling for temperature and other factors. Increases in fine particles, ozone and nitrogen dioxide resulted in an increased number of infant deaths 3 to 5 days later. The effect of particles was the most consistent and the least sensitive to the presence of other pollutants.

A study by EPA scientist Dr. Tracey Woodruff et al., of 86 cities in the United States reported an association between infant mortality and the level of inhalable particles in the first two months of life.


Air Pollution In Highly Polluted Regions May Cause Low Birth Weight Infants

Low birth weight is the most important predictor for neonatal mortality in developed and developing countries, and is a significant determinant of infant health and survival. A large study in Beijing, China looked at maternal exposure to air pollution during pregnancy and subsequent birth weight of infants. Coal stoves used for heating and cooking are a major source of indoor and outdoor air pollution in the study region. Xiaobin Wang of the Boston University School of Medicine and colleagues found a significant exposure-response relationship between maternal exposure to sulfur dioxide and total suspended particles during the third trimester of pregnancy and low birth weight.


ASTHMA EXACERBATION
Children’s Emergency Room Visits for Asthma Increase on High Air Pollution Days

"Asthma is the most common chronic illness in children and the cause of most school absences," state Norris et al., in their study of children’s emergency department visits for asthma. University of Washington investigators found significant associations between pediatric hospital visits for asthma and increased daily concentrations of PM and carbon monoxide in Seattle. Significantly, exacerbation of asthma was evident even when daily PM$_{2.5}$ concentrations were substantially below the level of the newly adopted National Ambient Air Quality Standard of 15 ug/m$^3$ annually.

In perhaps the largest study of pediatric asthma visits to date, Dr. Paige Tolbert, of the Rollins School of Public Health at Emory University, and co-investigators, obtained data on emergency department visits for three summers from seven large Atlanta area hospitals. The study included information on a variety of pollutants including spatial resolution of ozone data, a broad range of exposure levels, and a balanced distribution of socioeconomic status in the study population.

Increases in both ozone and particulate matter were found to heighten the risk of pediatric emergency room visits for acute asthma. According to the authors, "the study suggests continuing health risks at pollution levels that commonly occur in many U.S. cities," and "supports accumulating evidence regarding the relation of air pollution to childhood asthma exacerbation."


Children with Asthma are More Susceptible to Respiratory Effects

Increased particle concentrations have been associated with acute reductions in lung function and increased symptom reporting in children, including children with asthma. Dr. Sverre Vedal, Professor of Medicine at the University of British Columbia, and co-workers followed a group of 2,200 elementary school children in a pulp mill community on Vancouver Island, in Canada. Concentrations of potentially important copollutants such as sulfur dioxide, ozone, and acid aerosol were very low in the study community.

Vedal et al. found that children experience declines in peak expiratory flow, a measure of respiratory function, and increased symptoms such as cough, phlegm production, and sore throat, after increases in relatively low 24-hour PM$_{10}$ concentrations. Children with asthma were found to be more susceptible to these effects than other children.
Children’s Asthma Symptoms Increase on High Pollution Days

This study followed a group of 133 children with mild to moderate asthma, ages 5-13, in the Seattle, Washington area. Daily reports of asthma symptoms were obtained from study diaries and compared with daily air pollution levels during 1994 and 1995. Researchers found that a 30 percent increase in symptoms for each 10 µg/m³ increase in PM₁₀ and an 18 percent increase in symptoms for a 10 µg/m³ increase in PM₁₀. Effects were also increased with carbon monoxide increases, which authors assume serves as a marker for vehicle exhaust. Study authors conclude: “These results for daily symptoms complement the other Seattle-area studies that found air pollution health effects for emergency department visits and hospital admissions. Taken together, these studies suggest that the health effects among asthmatics from short-term changes in air pollution levels are an important public health problem.”


Particulate Pollution Worsens Bronchitis in Asthmatic Children

A University of Southern California School of Medicine study of more than 3,600 fourth, seventh and tenth grade children relied on parent questionnaires to identify children with pre-existing asthma or wheeze, and to assess their bronchitic symptoms. The students lived in 12 communities in Southern California with a broad range of air pollution levels: Alpine; Atascadero; Lake Elsinore; Lake Gregory; Lancaster; Lompoc; Long Beach; Mira Loma; Riverside; San Dimas; Santa Maria; and Upland, California. Children with asthma were much more likely than other children to experience bronchitis and phlegm in relation to PM₁₀ exposures.


Cleaning Up Air Pollution Improves the Respiratory Health of Children
A rather dramatic improvement in air quality in East Germany occurred following the German reunification in 1990. Researchers wanted to study if the declines in air pollution had produced a corresponding improvement in health, and they focused in on a cohort of first-, third-, and sixth-grade children in three East German communities. During the study period, bronchitis, ear infections, and frequent colds were dramatically reduced. Authors found that “the prevalence of nonasthmatic respiratory symptoms and diseases was higher in children living in more polluted communities, especially with respect to TSP and SO₂, suggesting that disease occurrence may be reduced within a short period by improvement in air quality.”


RECENT RISK ASSESSMENTS

Air Pollution from Power Plants Responsible for 30,000 Premature Deaths Each Year in U.S.

This analysis by Abt Associates used EPA-approved emissions and air quality modeling techniques to forecast ambient air quality in 2007, assuming full implementation of the Clean Air Act’s acid rain control program, and the EPA’s 1999 “NOₓ State Implementation Plan (SIP) call.” Analysts then applied risk functions derived from epidemiological studies to estimate health impacts of power plant emissions in the U.S. The focus of the study was on gaseous emissions of sulfur dioxide and nitrogen oxides that are converted in the atmosphere to fine particle sulfates and nitrates. The analysis estimated that 30,100 deaths may be attributed to power plant emissions each year. In addition, power plant emissions causes 20,100 hospitalizations for respiratory and cardiovascular causes, more than 7,000 asthma-related emergency room visits, 18,600 cases of chronic bronchitis, 600,000 asthma attacks, over 5 million lost work days, and over 26 million minor restricted activity days. Reductions in emissions from uncontrolled power plants could substantially reduce the adverse health effects.

In addition, analysis used a simpler model to estimate the impacts of emissions from on- and off-road diesel engines. The analysis reported that 15,400 premature deaths each year are attributable to the diesel contribution to fine particle concentrations. In addition, there are an estimated 11,100 cases of chronic bronchitis due to diesel emissions, thousands of hospitalizations due to chronic obstructive pulmonary disease, pneumonia, asthma, and cardiovascular causes, and over a million cases of minor illness such as acute bronchitis, upper and lower respiratory symptoms, and asthma attacks. Because of the use of different models, these results are not directly comparable to the power plant estimates.

Air Pollution Causes 40,000 Premature Deaths Each Year in Alpine Countries

As part of an assessment prepared for the World Health Organization, Nino Künzli and coauthors estimated health risk attributable to PM$_{10}$ pollution in three European countries, Austria, France, and Switzerland. Using functions of health risk obtained from epidemiological studies, the authors estimate that air pollution caused six percent of total mortality, or more than 40,000 cases each year, with about half associated with motor vehicle pollution. In addition, the study estimated that 47,000 new cases of chronic bronchitis in adults, more than 500,000 episodes of bronchitis in children, and more than a million asthma attacks are attributable to air pollution each year. Despite uncertainties inherent in risk assessment, this analysis highlights the magnitude of the public health burden attributable to current levels of air pollution.

APPENDIX
I

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epidemiology of Fine Particulate Air Pollution and Human Health: Biologic Mechanisms and Who’s at Risk?

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This article briefly summarizes the epidemiology of the health effects of fine particulate air pollution, provides an early, somewhat speculative, discussion of the contribution of epidemiology to evaluating biologic mechanisms, and evaluates who’s at risk or is susceptible to adverse health effects. Based on preliminary epidemiologic evidence, it is speculated that a systemic response of fine particle-induced pulmonary inflammation, including cytokine release and altered cardiac autonomic function, may be part of the pathophysiologic mechanisms or pathways linking particulate air pollution with cardiopulmonary disease. The elderly, infants, and persons with chronic cardiopulmonary disease, influenza, or asthma are most susceptible to mortality and serious morbidity effects from short-term acutely elevated exposures. Others are susceptible to less serious health effects such as transient increases in respiratory symptoms, decreased lung function, or other physiologic changes. Chronic exposure studies suggest relatively broad vulnerability to cumulative effects of long-term repeated exposure to fine particulate pollution, resulting in substantive estimates of population average loss of life expectancy in highly polluted environments. Additional knowledge is needed about the specific pollutants or mix of pollutants responsible for the adverse health effects and the biologic mechanisms involved. Key words: air pollution, cardiopulmonary disease, health effects, life expectancy, particulate pollution, review.


It has long been known, or at least suspected, that there are adverse health effects associated with ambient air pollution (1). Extensive air pollution episodes in the 1930s-1950s were associated with dramatically elevated cardiovascular morbidity and mortality. Evidence of serious health effects provided by these episodes spurred a growing concern about air pollution in the United States during the 1950s through early 1970s, there was a series of legislative efforts related to trying to control air pollution. Current air pollution legislation is based largely on the 1970 Clean Air Act and 1990 Amendments to this act (2). The amended Clean Air Act mandated national ambient air quality standards for pollutants that are relatively common and widespread but may reasonably be anticipated to endanger public health. Six pollutants that met these basic criteria (particulate pollutants) were eventually selected, including particulate matter (PM), sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead.

Since 1970 there have been hundreds of published studies that have evaluated the health effects of these air pollutants. A 1996 review of the health effects of these criteria pollutants (along with two other common pollutants) was prepared by the Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society (ATS) (2). There have also been numerous recent reviews that have focused on health effects of particulate air pollution (3-14). This article does not attempt to replicate the excellent ATS review of all the criteria pollutants or previous general reviews of particulate air pollution. The overall plan of this article is to focus on three basic topics. First, the epidemiology of the health effects of fine particulate air pollution (PM$_{2.5}$) (particles $\leq$ 2.5 $\mu$m) will be briefly summarized, although recent, more comprehensive reviews are available. This summary relies heavily on updates of several previous reviews by Dockery and Pope (6,8-11). Second, a somewhat speculative discussion of the early but clearly incomplete contribution of epidemiology to evaluating the biologic mechanisms is provided. This discussion of biologic mechanisms is updated from papers originally prepared for presentation at international symposia (10,11). Finally, an original discussion of who risks adverse health effects due to exposure to fine particulate air pollution is presented.

Characteristics of Fine Particles

Particulate air pollution refers to an air suspended mixture of solid and liquid particles that vary in size, composition, and origin. The size distribution of total suspended particles (TSP) in the atmosphere is trimodal and includes coarse particles, fine particles, and ultrafine particles. Coarse particles (often defined as those with an aerodynamic diameter $> 2.5 \mu$m) are often naturally occurring and derived primarily from soil and other crustal materials. Fine particles (PM$_{2.5}$) are derived chiefly from combustion processes in transportation, manufacturing, power generation.

Sulfate and nitrate particles are commonly generated by conversion from primary sulfur and nitrogen oxide emissions, and a varying portion of sulfate and nitrate particles may be acidic. Therefore, in most urban areas, PM$_{2.5}$ mostly comprises primary combustion-source particles as well as secondary combustion particles including sulfates and nitrates. Ultrafine particles are often defined as particles $< 0.1 \mu$m. These particles have relatively short residence times in the atmosphere because they accumulate or coagulate to form larger fine particles.

Various physiologic and toxicologic considerations suggest that exposure to fine particles may be a health concern. Their size is such that they can be breathed more deeply into the lungs. They include sulfates, nitrates, acids, metals, and carbon particles with various chemicals adsorbed onto their surfaces. Relative to coarse particles, they more readily penetrate indoors, are transported over longer distances, and are somewhat uniform within communities, resulting in highly ubiquitous exposure.

The initial reference method for measuring particle concentrations and establishing health standards was TSP. In 1987 the U.S. Environmental Protection Agency (U.S. EPA) changed the reference method to include only inhalable particles. Inhalable particles refers to those particles that can penetrate the thoracic airways; for purposes of standard setting, inhalable particles were specifically defined as particles $\leq 10 \mu$m in aerodynamic diameter (PM$_{10}$). In 1997 the U.S. EPA promulgated new standards (15) for an even finer cut of particulate air pollution—particles $\leq 2.5 \mu$m in aerodynamic diameter (PM$_{2.5}$); however, in May 1999, a U.S. Court of Appeals blocked the implementation of these standards.

Health Effects of Acute Exposure

The large majority of epidemiologic studies of particulate air pollution have been acute exposure studies that evaluated short-term
(usually daily) variations in health endpoints such as mortality counts, hospitalizations, symptoms, and lung function associated with short-term variations in levels of pollution. A brief summary of the results of these acute exposure studies is presented in Table 1. Unfortunately, until recently (following the promulgation of the new PM2.5 standards), there has been very little daily monitoring of fine particles, and most of the studies summarized in Table 1 used alternative measures of particulate concentrations.

**Episode Studies**

The earliest and most methodologically simple epidemiologic studies are those that evaluate air pollution episodes. These studies compare mortality (and morbidity) before, during, and after pollution episodes. In December 1950 in the Smoky Valley, Belgium, in October of 1948 in Donora, Pennsylvania, and in December of 1952 in London, England, stagnant air masses resulted in marked increases in the concentrations of air pollutants. Although the biologic mechanisms were not well understood, the large excess mortality and morbidity associated with the extreme episodes clearly demonstrated a link between mortality and morbidity and air pollution. During these episodes of highly stagnant air conditions, the PM2.5 pollution would have been primarily from combustion sources, and therefore PM2.5 mass would have been mostly fine particles. Two recent studies of less severe air pollution episodes (1/65) suggested smaller mortality and morbidity effects associated with less extreme pollution.

**Mortality Counts**

Many recent daily time-series mortality studies have also observed changes in daily death counts associated with short-term changes in particulate air pollution, even at relatively low or moderate concentrations (Table 1). There have been more than 60 such studies conducted in at least 35 cities. The relative risk of mortality increased monotonically with particulate concentrations, usually in a linear or near-linear fashion. These studies did not observe a particular pattern of pollution health effects threshold. In addition, these studies often observed a lead-lag relationship between air pollution and mortality. The results suggested that the increased mortality occurred concurrently or within 1–5 days following an increase in air pollution. Because various measurements of particulate pollution were used in the different studies, and because various modeling strategies were used, precise comparisons of effect estimates across all the studies were difficult. However, changes in daily mortality associated with particular air pollution were typically estimated at approximately 0.5–1.5%/10 μg/m³ increase in PM2.5 concentrations, or about 5 or 6 μg/m³ increase in PM2.5 concentrations.

Studies that provided a breakdown of mortality by broad cause-of-death categories observed that particulate air pollution generally had the largest effect on respiratory and cardiovascular disease mortality. Estimates of daily mortality effects of an increase in exposure to particulate air pollution by broad cause-of-death categories are summarized in Table 2. The estimated cause-specific increase in mortality risk is much larger for respiratory than for cardiovascular disease. However, the percent of excess deaths attributable to particulate exposure is mostly due to cardiovascular disease.

**Hospitalizations**

Daily counts of hospital admissions can be analyzed in a manner similar to the assessment of daily counts of mortality. More than 50 daily time-series studies have reported associations between particulate air pollution and hospitalization or related health endpoints (Table 1). Most of these studies have evaluated associations between respiratory hospital admissions and air pollution. Several studies have also analyzed emergency department visits for asthma, chronic obstructive pulmonary disease, and other respiratory ailments, and observed associations with particulate air pollution. More recent studies have observed associations between particulate air pollution and hospitalizations for cardiovascular disease (73,74,87,98–100).

**Symptoms/Lung Function**

There are more than 60 published studies evaluating associations between daily respiratory symptoms and/or lung function and particulate air pollution (Table 1). Although many of these studies focused on asthma exacerbation and asthmatics, others followed nonsmokers and evaluated changes in acute respiratory health status more generally. Small, often statistically insignificant, associations between particulate pollution and upper respiratory symptoms were observed. Associations with lower respiratory symptoms and cough, however, were typically larger and usually statistically significant. Exacerbation of asthma, based on recorded asthma attacks or increased bronchodilator use, were also associated with particulate air pollution. Associations between more general measures...
of acute disease have been studied, including evaluations of the timing of restricted activity
of U.S. adult workers due to illness (131, 132) and school absences in grade
school children (141).

Measures of lung function have also been used as an objective and potentially sensitive
indicator of acute response to air pollution. Various studies have taken repeated measure-
ments of the lung function of panels of children and/or adults. These studies have
typically reported very small but often statistically significant decreases in lung function
associated with elevated levels of particulate air pollution concentrations. Lagged effects of
up to 7 days were observed.

Effects of Chronic Exposure

The previously discussed acute exposure studies indicate that short-term exposures to
elevated particulate air pollution are associated with short-term changes in cardio-
pulmonary health. These acute exposure studies provide little information about how
much life is shortened, how pollution affects long-term mortality rates, or pollution's
potential role in the process of inducing chronic disease that may or may not be life
threatening. Chronic exposure studies evaluate health end points across communities or
neighborhoods with different levels of average pollution over longer time periods (usually 1
year or more). Chronic exposure studies attempt to evaluate the effects of low or moder-
ate exposure that persists for long periods as well as the cumulative effects of repeated
exposure to substantially elevated levels of pollution. A brief summary of the results of the
chronic exposure studies is provided in Table 3.

Mortality Rates

Several population-based, cross-sectional mortality studies have evaluated associations
between annual mortality rates and particulate air pollution across U.S. metropolitan
areas (Table 3). The basic conclusions from these population-based cross-sectional studies
were that mortality rates were associated with air pollution, and they were most strongly
associated with fine or sulfate PM. Such associations are illustrated in Figure 1. Age, sex,
and race-adjusted population-based mortality rates for U.S. cities in 1980 are plotted over
various indices of particulate air pollution obtained from Lipsett et al. (158) and U.S.
EPA (163). Although much apparent stochastic variability exists, adjusted mortality
rates are positively correlated with fine (PM2.5) and sulfate particles but not with
TSPs. Multiple regression modeling techniques to evaluate cross-sectional differences
in air pollution and mortality and to control for other ecologic variables have been used.
Table 4. Comparisons of mortality risk ratios (95% confidence interval) for air pollution from the Harvard Six-City, ACS, and post-neonatal infant mortality studies.

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Six-Cities (18.6 μg/m³ PM_{10})</th>
<th>ACS (24.5 μg/m³ PM_{2.5})</th>
<th>ACS (10.9 μg/m³ SO_{2})</th>
<th>Infant (56.6 μg/m³ PM_{10})</th>
<th>AHSMOG (males) (24.1 μg/m³ PM_{10})</th>
<th>AHSMOG (females) (24.1 μg/m³ PM_{10})</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1.26 (1.08-1.47)</td>
<td>1.17 (1.09-1.25)</td>
<td>1.15 (1.09-1.22)</td>
<td>1.25 (1.12-1.47)</td>
<td>1.11 (0.93-1.29)</td>
<td>0.94 (0.84-1.04)</td>
</tr>
<tr>
<td>Cardiopulmonary</td>
<td>1.37 (1.11-1.69)</td>
<td>1.31 (1.17-1.48)</td>
<td>1.26 (1.16-1.37)</td>
<td>---</td>
<td>1.10 (0.93-1.30)</td>
<td>0.92 (0.80-1.05)</td>
</tr>
<tr>
<td>Respiratory mentioned†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.23 (0.95-1.61)</td>
<td>1.10 (0.86-1.40)</td>
</tr>
<tr>
<td>SIDS, NBW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.91 (1.46-2.44)</td>
<td>---</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>1.27 (0.81-2.31)</td>
<td>1.03 (0.80-1.33)</td>
<td>1.28 (1.11-1.55)</td>
<td>3.26 (1.97-7.19)</td>
<td>1.33 (0.80-2.99)</td>
<td>---</td>
</tr>
<tr>
<td>All others</td>
<td>1.07 (0.79-1.44)</td>
<td>1.01 (0.82-1.24)</td>
<td>1.01 (0.82-1.11)</td>
<td>1.00 (0.94-1.06)</td>
<td></td>
<td>---</td>
</tr>
</tbody>
</table>

Abbreviations: NBW, normal birth weight; PM, particulate matter; SIDS, sudden infant death syndrome.†Any mention on the death certificate of nonsignificant respiratory disease as an underlying or contributing cause of death. NBW.

mortality studies have severe limitations and have been discounted for several reasons. An overriding concern is that they cannot directly control for individual differences in other important risk factors including cigarette smoking.

### Survival/Life Expectancy

Several cohort-based mortality studies have evaluated effects of long-term pollution exposure. The first of these studies, often referred to as the Harvard Six-City study (162), involved a 14 to 16-year prospective follow-up of more than 8,000 adults living in six U.S. cities. It controlled for individual differences in age, sex, cigarette smoking, education levels, body mass index, and other risk factors. Cardiopulmonary mortality was significantly associated with mean sulfate and fine particulate concentrations over the years of the study period.

A second study, referred to as the ACS study, linked individual risk factor data from the American Cancer Society, Cancer Prevention Study II (CPS-II) with national ambient air pollution data (163). The analysis used data for more than 500,000 persons who lived in up to 151 different U.S. metropolitan areas and who were followed prospectively from 1982 through 1989. It controlled for individual differences in age, sex, race, cigarette smoking, and other risk factors, and evaluated the association of adjusted mortality with two indices of long-term exposure to combustion-source particulate air pollution, mean sulfate, and median fine particles. Both indices of combustion-source particulate air pollution were associated with overall mortality and especially with cardiopulmonary mortality.

In both the Harvard Six-City study (162) and the ACS study (163), the positive association between combustion-related air pollution and cardiopulmonary mortality was dominated by cardiovascular disease deaths. However, because of concerns about cause-of-death coding on the death certificates, respiratory and cardiovascular deaths were grouped together and analyzed as cardiopulmonary deaths.

A study of post-neonatal infant mortality in the U.S.-linked National Center for Health Statistics birth and death records for infants born between 1989 and 1991 with PM_{10} data from the U.S. EPA's AERMOD Database (164). The full data set included approximately four million infants in 86 U.S. metropolitan areas. Because all infants in the study had PM_{10} exposure for at least part of 2 months, the analysis compared post-neonatal infant mortality across different levels of ambient PM_{10} concentrations during the 2 months following birth. The analysis controlled for individual differences in maternal race, marital education, marital status, month of birth, maternal smoking during pregnancy, and ambient temperatures. Particulate pollution exposure was associated with post-neonatal infant mortality for all causes, respiratory causes, and sudden infant death syndrome.

A final cohort study, known as the Adventist Health Study of Smog (AHSMOG), related air pollution to 1977-1992 mortality in more than 6,000 nonsmoking adults living in California, predominantly from the three metropolitan areas of San Diego, Los Angeles, and San Francisco (165). All natural cause mortalities, nonmalignant respiratory mortalities, and lung cancer mortalities were significantly associated with ambient PM_{10} concentrations in men, but not in females. Cardiopulmonary disease mortality was not significantly associated with PM_{10} in either males or females. Unfortunately, this study did not have direct measures of PM_{2.5}, but relied on TSP and PM_{10} data. Furthermore, the cohort was relatively small and was predominantly from only three metropolitan areas, San Diego, Los Angeles, and San Francisco.

Comparisons of mortality risk ratios for air pollution from the Six-Cities, ACS, infant mortality, and AHSMOG studies are presented in Table 4. The estimated overall excess risk from the infant mortality study is similar to those estimated for adults in the Harvard Six-Cities and ACS studies, even though the time frame of exposure for the infants was clearly far shorter than for the adults. This observation suggests that the relevant time frame of exposure is short (a few months vs years) and/or that infants are at greater risk for exposure to air pollution.

### Disease/Lung Function

There have also been several studies evaluating associations between chronic exposure and particulate air pollution and respiratory symptoms and disease or lung function (Table 5). The effects of air pollution on respiratory disease or symptoms were often estimated while adjusting for individual differences in various other risk factors. Significant associations between particulate air pollution and various respiratory symptoms were often observed. Chronic cough, bronchitis, and chronic illness (but not asthma) were associated with various measures of particulate air pollution. Studies that evaluated effects of air pollution on lung function adjusted for individual differences in age, race, sex, height, and weight, and controlled for smoking or restricted the analysis to never-smokers. These studies observed small associations between decreased lung function and particulate air pollution that were often statistically significant.

### Stylized Summary of Effects

The overall epidemiologic evidence is enhanced if adverse effects of exposure are reproducibly observed by different investigators in different settings. That is, there should be consistency of effects across independent studies. The evidence is further strengthened by a coherence of effects observed across a cascade of related health outcomes. Figure 2 presents a stylized summary of effect estimates of exposure to particulate air pollution. The effect estimates are not precise because different studies used various measures of pollution, different models, and different defined health endpoints. In addition, the recent rapid growth of the literature in this area makes effect estimates a moving target. Figure 2, therefore, should be considered stylized but illustrative. The estimates for the
time-series studies are reviewed from recent reviews (6,8). The effect estimates for cross-sectional and cohort studies are based on selected studies that are reasonably representative. The population-based mortality estimate is based on results presented by Krzyzosiak et al. (159), Li (157), Li et al. (58), and Okabe et al. and Thurston (160). The cohort-based mortality estimates are based on Dockery et al. (162), Pope et al. (63), and Wachter et al. (164), respectively. Bronchitis, children’s lung function, and adult lung function estimates are based on results reported by Dockery et al. (167), Aieta et al. (173), and Ackerman et al. (175), respectively.

As illustrated in Figure 2, a remarkable cascade of cardiopulmonary health endpoints has been observed. This includes death from cardiac and pulmonary disease, emergency room and physician office visits for asthma and chronic obstructive pulmonary disease, hospital admissions for cardiopulmonary disease, increased reported respiratory symptoms, and decreased measured lung function. The overall epidemiologic evidence indicates a probable link between fine particulate air pollution and adverse effects on cardiopulmonary health. However, there remains uncertainty about the role of chemistry versus size of the particles, the role of copollutants, and the use of central-site air quality monitoring to estimate the effects on individuals who spend most of their time indoors. In addition, there remains substantial uncertainty with regard to the biologic plausibility of these associations.

What Are the Biologic Mechanisms?

Our knowledge about the underlying biologic mechanisms remains limited and requires much additional study. The results of the epidemiology outlined above, however, provide a pattern of effects that may be biologically germane. Biologic plausibility is enhanced by the observation of a coherent cascade of cardiopulmonary health effects and by the fact that non cardiopulmonary health endpoints are not typically associated with the pollution. In addition, as summarized in Table 5, very recent epidemiologic studies have attempted to look at specific biologic endpoints, in addition to lung function, that may be part of the pathophysiologic pathway linking cardiopulmonary mortality and particulate air pollution.

One hypothesized general pathway includes pollution-induced lung damage (potentially including oxidative lung damage and inflammation), decline in lung function, respiratory distress, and cardiovascular disease potentially related to hypoxemia (177). Evidence of pollution-related inflammation has been observed (183-185) and, as indicated above, several studies have reported declines in lung function associated with elevated particulate pollution exposures. However, a study of potential PM-related hypoxemia did not observe declines in low oxygen saturation associated with elevated exposures to particulate air pollution (177).

Alternatively, the autonomic nervous system may play an important role in the pathophysiologic pathway between particulate exposure and cardiopulmonary disease. Seaton et al. (186) hypothesized that fine particulate air pollution may provoke acinar inflammation, resulting in the release of potentially harmful cytokines and increased blood coagulability. Autonomic nervous system–activated changes in blood viscosity, heart rate (HR), and heart rate variability (HRV) may increase the likelihood of cardiac death (187). A recent epidemiological study (177-183) have evaluated such autonomic nervous system–related physiologic measures and air pollution, although they have been extremely limited and mostly exploratory pilot studies.

Peters et al. (178) evaluated blood plasma viscosity from a random sample of men and women living in Augsburg, Germany, during the winter of 1984-1985. Between January 4 and 7, 1985, there was a pollution episode with marked increases in sulfur oxide and particulate pollution concentrations. During this episode a significant increase in the risk of elevated plasma viscosity was observed. The odds ratios (and 95% confidence intervals [CIs]) for plasma viscosity were above the 95th percentile of the sample distribution; they were 3.6 (1.6-8.1) and 2.3 (1.0-5.3) for men and women, respectively.

A daily time-series panel study of elderly subjects with repeated measures of blood oxygenation did not observe pollution-related hypoxemia but did observe that elevated particulate air pollution levels were associated with increased pulse rate (177). A 100-mg/m³
inute in PM₁₀ on the previous 1–5 days was associated with an average increase in the pulse rate of 0.8 beats/min and a 29% and 95% increase in the odds of the pulse rate being elevated by 5 or 10 beats/min, respectively.

In a related study (187), repeated 24-hr ambulatory electrocardiograph (ECG) monitoring was conducted on seven subjects for a total of 29 days during episodes of high pollution and during periods of relatively low pollution. HR was positively associated with particulate air pollution. Additionally, beats between (R-R) HRV was analyzed to assess cardiac autonomic control. Particulate air pollution was associated with changes in HRV including: reduced 24-hr SDNN (the standard deviation of the average R-R intervals and an estimate of overall HRV); reduced SDANN (the standard deviation of the average R-R intervals in all 5-min segments of the 24-hr ECG recording and an estimate of long-term components of HRV); and increased rMSSD (the square root of the mean of squared differences between adjacent R-R intervals and an estimate of the short-term components of HRV). The associations between HRV and particulate pollution persisted even after controlling for mean HR, suggesting a possible link between elevated exposure to PM and lower cardiac autonomic control.

A prospective study of HRV and mortality in subjects with chronic heart failure was recently reported (187). Survival analysis conducted in this study included a Cox Proportional Hazards regression model to control for multiple risk factors. Based on this model the estimated risk ratio for a 41.2% decrease in SDNN (from 24-hr ambulatory ECG monitoring) was 1.62 (95% CI, 1.16–2.44). As an interesting but highly speculative look at plausibility, the 24-hr SDNN mortality relationship from this study can be combined with the decline in 24-hr SDNN associated with PM₁₀ from the above HRV study (188). The expected increase in mortality risk can then be estimated and compared with the PM-related cardiovascular mortality risk directly estimated from the PM mortality epidemiology studies. For example, the estimated mortality risk for PM₁₀ associated with 100 µg/m³ PM₁₀ was approximately 18% (SE = 4.9). Using the coefficients reported in these two studies (187, 188), the estimated mortality risk ratio of an 18% decline in 24-hr SDNN can be calculated as 1.23 (95% CI 1.12–1.32). This risk ratio seems somewhat plausible. It is larger than risk ratios for total or cardiovascular disease mortality that are generally estimated from daily time-series studies but smaller than risk ratios estimated from the prospective cohort mortality studies of long-term chronic exposure.

Recent animal studies have observed some unexpected results (188–194), but the epidemiologic observations are preliminary and based on only a few studies, most of which were exploratory pilot studies. These changes may reflect PM-induced pulmonary inflammation, cytokine release, and altered cardiac autonomic function as part of the pathophysiologic mechanisms or pathways linking PM and cardiovascular mortality. In general, it is speculated that alterations in air pollution-mediated inflammation, abnormal hemodynamic function, and altered cardiac rhythm may play an important role in the pathogenesis of cardiopulmonary diseases related to air pollution. An adequate understanding of these relationships clearly requires further research.

Who’s at Risk?

The question of who is at risk or who is susceptible to adverse health effects of fine PM pollution does not have an easy answer. It seems evident that the elderly, young children, and persons with chronic cardiopulmonary disease, influenza, and asthma are most likely to be susceptible. However, this answer is far too simplistic. For example, assume a large population of non-smokers. Require all in the population to smoke a pack of cigarettes for a day and then stop. Who will be susceptible to this relatively short-term exposure to cigarette smoking? Morality and serious morbidity effects would most likely affect the very old, young, and those with asthma or chronic cardiopulmonary disease. This does not mean that others are unaffected. For healthy, middle-aged adults, the effects are unlikely to be immediately life threatening, but short-term adverse effects such as coughing, throat and eye irritation, or even mild or moderate cigarette smoke-induced pulmonary inflammation may be experienced. Further suppose smoking does not stop after 1 day but continues throughout the lives of all in the population. Now who is susceptible to exposure to cigarette smoke? Over a lifetime, the chronic exposure has the potential to eventually affect all. Although the exposures and effects for active cigarette smoking are much larger, cigarette smoking has been associated with a spectrum of cardiopulmonary diseases similar to those associated with fine PM. Interestingly, a decrease in HR and an increase in HRV have also been observed following smoking cessation (195).

Clearly, the answer to the question of who is susceptible is not simple but is dependent on the health effects being evaluated and the level and length of exposure.

At Risk from Short-Term, Acute Exposure

A summary of who may be susceptible to various adverse health effects from PM...
table and overall health relevance is described in Table 6. With respect to acutely elevated exposures, reflected by day-to-day changes in PM, those susceptible to dying are the elderly, the very young, and persons with chronic cardiopulmonary disease, influenza, or asthma. During the London episode of 1952, for example, approximately 80–90% of the excess deaths were in adults with respiratory and/or cardiovascular disease that was generally chronic in nature. There was also an approximate doubling of deaths in children less than 1 year of age (20). As summarized in Table 2, more recent daily time-series studies also observe that most of the excess mortality from PM exposure is from respiratory and cardiovascular disease deaths.

How much life shortening is due to acutely elevated levels of PM and how much of the mortality is due to short-term mortality displacement (harvesting) remains uncertain. The increased mortality is only in the most frail persons with little remaining life expectancy, then death may be advanced by only a few days or weeks. However, recent research using data from Philadelphia, Pennsylvania observed that the increase in mortality was inconsistent with only short-term mortality displacement and suggested that mortality for many may be substantially advanced (196). These results also suggest that those who are susceptible to increased risk of mortality from acutely elevated PM may include more than just the most old and frail who are already very near death.

On any given day, the number dying due to PM exposure is extremely small. Based on the 1996 average death rate for the United States (8.8/1,000/year) and the summary estimates presented in Table 2, a 50 pg/m³ increase in PM 2.5 would result in an average of only 1.7 deaths per day per one million people (compared to an expected case rate of approximately 24/day). This minimal excess deaths per day reflects the fact that the increased risk of mortality due to acutely elevated PM exposure is small, and on any given day there may only be a very small fraction of the population at serious risk of dying due to this acute exposure.

As summarized in Table 6, the number of those susceptible to being hospitalized because of acute PM exposure is probably also quite limited and similar to the number of those at risk of dying. However, the number of those susceptible to less serious health effects such as increased respiratory symptoms, decreased lung function, or other physiologic changes may be quite broad. For more people, these effects are likely small, transient, and may even be unnoticed. For a few, the decline in lung function may be clinically relevant (125), or the effects may result in short-term absence from work (131,132) or school (141).

At Risk from Long-Term Chronic Exposure

Long-term, repeated PM exposure has been associated with increased population-based mortality rates (155–160) as well as increased risk of mortality in broad-basedcohorts or samples of adults (162,163) and children (164) (Table 4). Chronic exposure studies of PM suggest rather broad susceptibility to cumulative effects of long-term repeated exposure. There is no evidence that increased mortality risk is unique to any well-defined susceptible subgroup. All who are chronically exposed may ultimately be affected. However, because the relative risk is small, the long-term cumulative effects are most likely to be observed in older age groups with relatively higher baseline risks of mortality.

To illustrate the potential cumulative mortality effects of PM, survival curves and life expectancies have been estimated under six different scenarios illustrated in Figure 5. The first curve is a baseline survival curve based on projected U.S. life tables prepared by the Office of the Chief Actuary in the Social Security Administration and obtained from the Berkeley Mortality Database (157). Although a survival curve for never-smokers and for persons not exposed to urban air pollution was not directly calculated, this projected baseline curve is used to represent a reasonable baseline estimate for the total U.S. population. The life expectancy of this baseline curve is equal to 76.4 years.

The second, third, and fourth survival curves are calculated from the baseline curve assuming an additional relative risk of mortality from PM exposure equal to 1.25. This is approximately the relative risk estimated in both the Harvard Six-Cities study (162) and the postmenopausal infant mortality study (164) for the relevant range of PM air pollution that exists in U.S. urban areas (Table 4). The only difference between the second, third, and fourth curves is the age at which people begin to be susceptible to the effects of pollution. Curves two, three, and four assume that susceptibility begins at age 45 years, age 1 year, and at birth, respectively. As can be seen in Figure 3, these three survival curves appear to be nearly identical. The close concurrence between these three curves is because the baseline mortality risk for infants, children, and young adults is so low compared to the baseline mortality risks for older adults. The estimated life expectancy for curves two, three, and four equal 73.9, 73.5, and 73.4 years, respectively. This suggests an average loss of life expectancy equal to 2.5, 2.9, and 3.1 years, respectively. Obviously, earlier onset ages of susceptibility result in greater

Table 6. Summary of who’s susceptible to adverse health effects from PM exposure and overall health relevance.

<table>
<thead>
<tr>
<th>Health effects</th>
<th>Who’s susceptible?</th>
<th>Overall health relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>Elderly, infants, persons with chronic cardiopulmonary disease, influenza, or asthma</td>
<td>Obviously relevant. How much life shortening is involved and how much is due to short-term mortality displacement (harvesting) is uncertain.</td>
</tr>
<tr>
<td>Hospitalization/other health care visits</td>
<td>Elderly, infants, persons with chronic cardiopulmonary disease, pneumonia, influenza, or asthma</td>
<td>Reflects substantive health impacts in terms of illness, discomfort, treatment costs, work or school time lost, etc.</td>
</tr>
<tr>
<td>Increased respiratory symptoms</td>
<td>Most consistently observed in people with asthma and children</td>
<td>Mostly transient effects with minimal overall health consequence, although for a few there may be short-term absence from work or school due to illness.</td>
</tr>
<tr>
<td>Decreased lung function</td>
<td>Observed in both children and adults</td>
<td>For most, effects seem to be small and transient. For a few, lung function losses may be clinically relevant.</td>
</tr>
<tr>
<td>Pneumonia, heart rate, heart rate variability, pulmonary inflammation</td>
<td>Observed in both healthy and unhealthy adults. No studies of children</td>
<td>Effects seem to be small and transient. Overall health relevance is unclear, but may be part of pathophysiological pathway linking PM with cardiopulmonary mortality.</td>
</tr>
<tr>
<td>Chronic exposure</td>
<td>Observed in broad-based cohorts or samples of adults and children (including infants). All chronically exposed potentially are affected</td>
<td>Long-term, repeated exposure appears to increase the risk of cardiopulmonary disease and mortality. May result in lower lung function. Population average loss of life expectancy in highly polluted cities may be as much as a few years.</td>
</tr>
</tbody>
</table>

Environmental Health Perspectives • Vol 108, Supplement 4 • August 2000
overall loss of life. Differences in assumptions about the age when susceptibility begins, however, make only small differences for the younger ages because of the relatively low baseline mortality risks.

Survival curve five in Figure 3 was calculated from the baseline curve assuming an additional relative risk of mortality from cigarette smoking from age 20 equal to 2.00. This is approximately the average relative risk of approximately average levels of smoking versus never smoking that was estimated in both the Harvard six-cities study (162) and the ACS study (162). The estimated average life expectancy for smokers was 67.9 years, a loss of life expectancy equal to 8.6 years. Clearly, cigarette smoking has a much larger impact on morality than ambient air pollution. However, this estimate of loss of life expectancy is not a population average, but the average loss to smokers only.

The sixth curve was calculated from the baseline curve assuming an additional relative risk of mortality from PM exposure equal to only 1.15. This is approximately the relative risk that was estimated from the ACS study (163) for the relevant range of PM air pollution in the United States (Table 4). Susceptibility was assumed to begin after infancy at age 1 year. The estimated life expectancy was 74.6 years, a loss of life expectancy equal to 1.8 years. These results are comparable to those obtained from two similar analyses (198,199).

Although the elevated risk associated with particulate air pollution exposure is relatively small compared with cigarette smoking, the public health significance of fine particulate air pollution, at least as measured in population average losses of life, is substantial for two basic reasons. Exposure is ubiquitous. Because fine particles are often generated indoors and ambient fine particles penetrate many indoor environments, essentially everyone is exposed. Furthermore, exposure is not a voluntary decision made as a teenager or in adulthood but occurs throughout life.

The above estimates of population average life lost from the pollution are probably a worst-case scenario for the United States. They use relatively large estimates of excess risk from chronic exposure to pollution from the recent prospective cohort studies of adults and the postneonatal infant mortality study. They assume that the risk effects are cumulative for all of the large parts of persons' lives, and they assume lifelong residence in one of the most polluted U.S. cities. Loss of life due to pollution exposure of 1-3 years for lifelong residents of highly polluted cities, however, is not unreasonable, especially in some of the more polluted cities in the world.

References and Notes

34. Lau JT, Shin D, Chung Y. Air pollution and daily mortality in the


APPENDIX

J
March 24, 2000

Tony Oliveira, Vice Chair
Kings County Board of Supervisors
1400 West Lacey Boulevard
Hanford, CA 93230

Re: Rebuttal of comments on the appeal of the Environmental Impact Report for the Boswell Dairy Complex

Dear Mr. Oliveira:

I am a private consulting scientist, specializing in air quality research and analysis. My office is in Santa Barbara, California. I hold a B.Sc. degree in Chemical Engineering from the University of California at Santa Barbara (1970). I have been engaged in analysis, research, and enforcement work in the field of air quality since 1973. My experience includes evaluating emissions of air contaminants and related impacts from a wide variety of stationary and mobile sources of air pollution for clients in the public and private sector. I have extensive experience preparing or participating in the preparation of air permits and environmental documents that satisfy the Clean Air Act, the California Health and Safety Code, local air quality rules and regulations, the California Environmental Quality Act ("CEQA") and the National Environmental Protection Act requirements. I have participated in rule-making and pollution control strategy development for public agencies. I have also served as an expert providing testimony, analysis, and advice on air pollution emissions for business and community groups, as well as for government agencies.

The Center on Race, Poverty, and the Environment ("CRPE") retained me to review the air quality sections of the referenced Environmental Impact Report ("EIR") and provide comments on their behalf to you as part of the rebuttal phase of their appeal of the Boswell dairy permits and EIR approval. I have reviewed the document and have found the analysis of air quality impacts to be incomplete, especially the identification and development of mitigation measures to reduce significant impacts and the analysis of cumulative impacts.

The EIR for the proposed Boswell Dairy Complex identifies ten "significant and unavoidable" impacts to air quality (five of the impacts are project-level; the same five impacts are significant and unavoidable on a cumulative level). These "significant and unavoidable" impacts would contribute both PM10 and reactive organic gas ("ROG") emissions to the San Joaquin Valley air basin, an area that is currently in nonattainment for both Federal and State PM10 and ozone standards (ROG is a precursor to ozone formation). Any contributions of PM10 and ROG emissions to the environment would
exacerbate this nonattainment status and would prohibit the County from complying with Federal and State mandates to improve air quality and attain the standards.

As I am sure you are aware, CEQA requires an EIR to identify and analyze mitigation measures to reduce or minimize any significant impacts. Given the current nonattainment status of the air basin for PM_{10} and ROG, it is even more important that the EIR for the Boswell Dairy Complex include a comprehensive listing and analysis of all reasonable and feasible mitigation measures that would reduce emissions or impacts from the proposed project. It is my opinion that the EIR does not present a comprehensive listing and analysis of all reasonable and feasible mitigation measures.

For example, Mitigation Measure 4.2-3 requires the operator to use “effective stabilization” to reduce fugitive PM_{10} emissions from cattle-movement and related activity using water or chemical stabilizer/suppressant. This unspecific and weakly worded mitigation measure would allow the operator to choose between water and a stabilizer to control dust. Since water is less expensive than chemical stabilizer/suppressants, it is likely that water would be used to control dust, even though chemical stabilizers are widely accepted as being a more effective control measure. The EIR should be revised to provide a complete analysis of control measure effectiveness, and the mitigation measures should be reworded to remove ambiguity. The most effective control measures should be required, not suggested and left to the discretion of the project operator.

Furthermore, the EIR did not analyze all mitigation measures that may be reasonable and feasible to reduce emissions from the proposed project. Although the EIR described two aerobic treatment systems used within the San Joaquin Valley air basin to reduce ROG emissions from dairy facilities, the EIR was unspecific about the type of treatment system required for the proposed project. This control strategy should have been thoroughly analyzed, as it has the potential to substantially reduce eight of the ten significant and unavoidable impacts. The EIR skirted the issue by stating that “the effectiveness of these control technologies in reducing ROG has not been critically evaluated”. I would argue that this is the time and place to evaluate these technologies and to require the most effective treatment option to be a part of the proposed project. A third-party analysis is more likely to be complete and unbiased than an analysis prepared by the project proponent after approval of the project.

Another option to reduce air quality impacts would be to reduce non-project PM_{10} emissions in the vicinity of the proposed project. In situations like this, it is feasible to offset emissions from one source using emission reductions from another nearby source. For example, it may be feasible in this case for the project applicant to convert a surrounding PM_{10}-generating land use to a non-polluting land use, i.e., land currently used for row crops could be converted to a wetland preserve or left fallow. These non-project emission reductions could be used to offset project-related emission increases, thus reducing the overall air quality burden on the local and regional air shed.
The analysis of cumulative impacts in the EIR is inadequate because emission estimates were not prepared for reasonably foreseeable future dairy and livestock projects in Kings County. While on one hand, the EIR states that a cumulative emission estimate was not possible to make, the document provides an estimate of recently approved and proposed farms and an estimate of herd sizes. With these data, using the same emission factors employed for the proposed project, an estimate of cumulative emissions could have been made. Due to the uncertainties associated with this estimate, a range of emission estimates may be advisable.

In conclusion, it is my opinion that the EIR has not fully complied with the requirements of CEQA, and any findings by Kings County that the EIR has, in fact, complied with CEQA requirements are incorrect. The EIR should be revised to include a more detailed analysis of reasonable and feasible mitigations, the mitigation measures should be revised to remove ambiguity, and cumulative impacts should be quantified. Thank you for the opportunity to comment during the rebuttal phase of CRPE’s appeal of the Boswell dairy permits and EIR.

Sincerely,

Cliff R. Scholle
Air Quality Scientist
CLIFF R. SCHOLLE

EDUCATION AND WORK SUMMARY:

University of California, Santa Barbara, Bachelor of Science, Chemical Engineering, 1970. Over 27 years of experience as an air quality scientist working in the design, implementation, and management of field research programs and environmental impact assessments. Management or participation in the preparation of complex environmental documents and permits; supervision of technical staff on a wide variety of environmental research and evaluation projects. Project manager for numerous programs ranging in complexity from single-source permit applications to multi-million dollar energy development projects. Environmental evaluation of a diverse range of projects, including the petrochemical, minerals processing, aerospace, maritime, and the wood products industries, as well as hazardous waste incineration. Technical analysis, review, or testimony as an expert for public agencies and community groups.

PROFESSIONAL EXPERIENCE:

Management and Supervision

Approximately 20 years experience managing projects and/or supervising personnel.

- Field and laboratory supervisor during numerous air quality research experiments for North American Weather Consultants between 1976 and 1983.

- Program manager and air quality section supervisor for Science Applications International Corporation and URS Consultants between 1986 and 1991. Responsible for all air quality analyses performed by staff.

- Project manager of the GTC Interim Marine Terminal Project and other projects for the Santa Barbara County Air Pollution Control District (SBCAPCD) between 1985 and 1996. Responsible for permit and compliance activities associated with the petrochemical industry.

- Principal of SEA Consultants since 1991.

Expert Services/Litigation Support

Technical review and/or testimony as an expert for air quality permits and environmental documents. Examples include:

- California Energy Commission cogeneration project permit applications.

- CEQA documents prepared for the expansion of petroleum refineries in the Los Angeles and San Francisco Bay area.
- Air permit applications to the South Coast Air Quality Management District for petroleum refinery modifications.
- Air permit application to the San Joaquin Valley Unified Air Pollution Control District for the expansion of a hazardous waste landfill.
- Air permit application to the San Diego County Air Pollution Control District for the Homeport Dredging project.
- San Diego Unified Port District methyl bromide fumigation monitoring plan review.
- CEQA documents prepared by the Department of Toxic Substances Control for potential releases of hazardous air contaminants.
- Analysis of a car-scraping facility in Los Angeles.
- Analysis of hexavalent chromium use in the aerospace industry.

**Ambient Air Monitoring**

- Responsible for the design, siting, fabrication, calibration, and maintenance of ambient air quality and meteorological monitoring stations for North American Weather Consultants. Conducted numerous ambient air quality monitoring studies throughout the Western and Midwestern States.
- Designed and fabricated specialized air monitoring equipment such as sequential air samplers, reactive pollutant sample containers, high flow-rate calibration systems, aircraft inlet probes, and a molecular diffusion manifold for ambient air sampling.
- Designed and fabricated aircraft-mounted air quality monitoring systems. Participated in airborne air quality monitoring studies.
- Conducted specialized air quality monitoring studies, including experiments that characterized ambient reactive hydrocarbon concentrations in urban and rural areas; ambient lead, hexavalent chromium, and perchloroethylene exposures in the South Coast Air Basin; and vehicular emission impacts in Colorado.
- Conducted a monitoring program for the Naval Explosive Ordnance Division to determine ambient concentrations of a wide variety of toxic compounds at the Marine Corps Air/Ground Combat Center in Twenty-Nine Palms, California.

**Air Permits/Regulatory Activities**

Extensive experience preparing and reviewing air quality permits in support of regulatory agencies, as well as for industrial source operators.

- Prepared emission inventories, air permits, and NEPA/CEQA documents for petrochemical facilities in Santa Barbara County, as an air pollution engineer for the SBCAPCD and as a private consultant.
• Developed emission factors for mobile and stationary sources for use in air
SBCAPCD permits and planning inventories.

• Participated in the enforcement of regulatory programs for air quality,
particularly in the implementation and technical work associated with AB
2588, the Air Toxics Hot Spots Act, and Proposition 65, the Safe Drinking

• SBCAPCD representative for resource planning studies, such as the Joint
Interagency Modeling Study, the South Central Cooperative Aerometric
Monitoring Program, the Petroleum Transportation Committee, and the Oil
Transportation Plan.

• Prepared scores of environmental analyses and/or permits for numerous source
types, including the minerals processing, petroleum processing, national defense,
aerospace, and wood products industries.

Environmental Review

Prepared, contributed to, or reviewed more than 100 Environmental Impact Reports
(EIR), Environmental Impact Statements (EIS), and/or environmental assessments
consistent with the California Environmental Quality Act and the National Environmental
Protection Act. Examples include:

• CEQA documents in support of the Technology and Environmental Assessment
Division of the SBCAPCD, including an EIR for the SBCAPCD Regulation II,
New Source Review and Prevention of Significant Deterioration.

• 2020 Master Plan and Feasibility Study, Channel Improvements, and Landfill
Developments EIS/EIR and Special Studies for the Corps of Engineers and Ports
of Los Angeles and Long Beach.

• Castle Mountain Gold Mine Project EIR/EIS.

• Numerous environmental documents evaluating the realignment of military
aircraft training flights for the Air Force Strategic Air Command and Air National
Guard.

Planning/Rule Making

• Contributed to the development of rules and associated staff reports for the
Monterey Bay Unified Air Pollution Control District.

• Contributed to the socioeconomic impact analyses (Palanco Bill) for proposed
San Diego Air Pollution Control District rules and regulations.

• Performed technical and economic evaluations of 38 control measures considered
for adoption into the Santa Barbara County 1991 Air Quality Attainment Plan.
Dispersion Analysis/Impact Assessment:

- Developed an SFg-tracer capability for use in atmospheric dispersion simulation experiments. Participated in SFg-tracer experiments, including the Central California Tracer and Model Validation Study for the Bureau of Land Management, the Cinder Cone Butte Dispersion Experiment for the Complex Terrain Modeling Program for the Environmental Protection Agency, the Long Range Transport of the Los Angeles Urban Plume Experiment for Southern California Edison Company (SCE), and the Tracer and Plume Model Validation Study for SCE.

- Assessed the vehicular emission impacts for numerous projects, including the expansion of the Staten Island Bridges for the New York and New Jersey Port Authorities and the revisions to the Solvang Circulation Element.

- Prepared health risk assessments for municipal wastewater treatment facilities in Santa Barbara County for the SBCAPCD.
APPENDIX K
4.2 AIR QUALITY

Clean air is a vital resource to public health and welfare, to the local agricultural economy, and to the quality of life. Air pollution adversely affects public health, diminishes the production and quality of agricultural crops, reduces visibility, degrades materials, and damages native vegetation. This section discusses regional air quality in the San Joaquin Valley air basin and sources and quantities of air emissions expected from the proposed project.

SETTING

CLIMATIC CONDITIONS

The project is located in the San Joaquin Valley air basin, which is defined by the Sierra Nevada in the east, the Coast Ranges in the west, and the Tehachapi mountains in the south. The surrounding topographic features restrict air movement through and out of the basin and, as a result, impede the dispersion of pollutants from the basin. Inversion layers are formed in the San Joaquin Valley air basin throughout the summer and winter; an inversion layer is created when a mass of warm dry air sits over cooler air near the ground, preventing vertical dispersion of pollutants from the air mass below. During the summer, the San Joaquin Valley experiences daytime temperature inversions at elevations from 2,000 to 2,500 feet above the valley floor; during the winter months, inversions occur from 500 to 1,000 feet above the valley floor (SJVUAPCD, 1998).

The average summer high temperature in Kings County is in the upper 90° F (degrees Fahrenheit) range; during the summer, wind rose data for the valley indicate that the wind usually originates from the north end of the San Joaquin Valley and flows in a southeasterly direction. During winter months, the average temperature in the County is in the low 50° F; wind flows from the south end of the San Joaquin Valley toward the north. Low wind speeds and low inversion layers during the winter result in high carbon monoxide and particulate matter concentrations (National Climatic Data Center, undated).

AIR QUALITY STANDARDS AND LEGISLATION

FEDERAL

National Ambient Air Quality Standards

National ambient air quality standards (NAAQS) for six criteria pollutants (carbon monoxide, ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and lead) were established by the Administrator of the U.S. Environmental Protection Agency (EPA)
through the 1970 Federal Clean Air Act (CAA) (Table 4.2-1). In July 1997, EPA promulgated new NAAQS for ozone and particulate matter with a diameter less than or equal to 2.5 microns (PM$_{2.5}$) (Table 4.2-1). The existing 1-hour ozone standard (0.12 ppm) will eventually be phased out and replaced with an 8-hour standard of 0.08 ppm.\(^1\) The new PM$_{2.5}$ standard has been established for both an annual average and 8-hour periods.

**TABLE 4.2-1: National and State Ambient Air Quality Standards**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Annual</th>
<th>8-hour</th>
<th>24-hour</th>
<th>1-hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone</td>
<td>8 hours</td>
<td>-</td>
<td>0.08 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>0.09 ppm</td>
<td>0.12 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>8 hours</td>
<td>9.0 ppm</td>
<td>9.0 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>20.0 ppm</td>
<td>35.0 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>Annual</td>
<td>-</td>
<td>0.053 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>0.25 ppm</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Annual</td>
<td>-</td>
<td>0.03 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>0.04 ppm</td>
<td>0.14 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>0.25 ppm</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended particulate matter; diameter ≤ 10 microns (PM$_{10}$)</td>
<td>Annual arithmetic mean</td>
<td>-</td>
<td>50.0 $\mu g/m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual geometric mean</td>
<td>30.0 $\mu g/m^3$</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>50.0 $\mu g/m^3$</td>
<td>150.0 $\mu g/m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended particulate matter; diameter ≤ 2.5 microns (PM$_{2.5}$)</td>
<td>Annual</td>
<td>-</td>
<td>15.0 $\mu g/m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td>-</td>
<td>65.0 $\mu g/m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>1 hour</td>
<td>0.03 ppm</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>Calendar quarter</td>
<td>-</td>
<td>1.5 $\mu g/m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30-day</td>
<td>1.5 $\mu g/m^3$</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Notes: ppm = parts per million.
$\mu g/m^3$ = micrograms per cubic meter.
- = Not available

\(^1\) However, as of the preparation of this EIR, the U.S. Court of Appeals for the District of Columbia Circuit has ruled that: 1) the revised ozone and new PM$_{2.5}$ standards were improperly adopted; 2) U.S. EPA is prohibited from enforcing the revised ozone standard; and 3) it is in the process of determining the course of action for PM$_{2.5}$. 

Kings County  
15 October 1999  
99225bos.air.wpd-10/13/99  
CHAMBERLAIN RANCH PROJECT  
4.2 Air Quality

001531  
007943
The CAA and subsequent Federal Clean Air Act Amendments of 1977 and 1990 require geographical areas to be designated as in attainment or nonattainment with the national ambient air quality standards. A geographical area is considered to be in attainment if the air pollutant level for that area meets the corresponding national standard; geographical areas for which an air pollutant exceeds the corresponding national standard are classified as nonattainment areas. State Implementation Plans (SIP) must be developed for nonattainment areas to identify strategies for achieving attainment of the national standard.

The San Joaquin Valley is currently in nonattainment for the Federal standards for ozone and particulate matter with an aerodynamic diameter less than or equal to ten microns (PM\textsubscript{10}). As a result, the San Joaquin Valley Unified Air Pollution Control District (SJVAUPCD) has prepared PM\textsubscript{10} and ozone attainment demonstration plans; these plans identify the regulatory framework necessary to bring the San Joaquin Valley into compliance with the Federal ozone and PM\textsubscript{10} standards. The PM\textsubscript{10} attainment demonstration plan was approved by the California Air Resources Board (CARB) on 26 June 1997 and constitutes the PM\textsubscript{10} SIP for the San Joaquin Valley; the PM\textsubscript{10} SIP has not yet been approved by EPA (Guerra, 1999). The ozone attainment demonstration plan was incorporated into CARB’s 1994 ozone SIP; CARB’s ozone SIP also includes attainment demonstration plans for nonattainment areas other than the San Joaquin Valley and statewide measures intended to attain the Federal ozone standard. The 1994 ozone SIP was approved by EPA on 25 September 1996.

**Methane**

Regulatory requirements for the reduction or control of methane emissions have not been established on the Federal, State, or local levels. However, EPA prepares methane emission source inventories on an ongoing basis, as required by the CAA amendments. The five major anthropogenic sources of methane in the United States have been identified to be (in order of contribution) landfills, domesticated livestock, natural gas and oil production, coal mining, and livestock manure (U.S. EPA, 1999). Methane has been determined to be the second most significant greenhouse gas that contributes to global warming. The effects of greenhouse gases have been recognized as a worldwide problem and international efforts are being made to reduce the emission of these gases (U.S.EPA, 1995).

In 1988, the United Nations established the Intergovernmental Panel on Climate Change to evaluate the impacts of global warming and to develop strategies that nations could implement to curtail global climate change. In 1992, the United States joined with other countries around the world in signing the United Nations’ Framework Convention on
Climate Change agreement; the goal of the agreement was to control greenhouse gas emissions, including methane.\textsuperscript{2}

As a result, the Climate Change Action Plan was developed to address the reduction of greenhouse gases in the United States. The plan consists of more than 50 voluntary programs, including the Ruminant Livestock Efficiency Program (RLEP) and AgStar Program.\textsuperscript{3} The RLEP, developed by EPA in coordination with the U.S. Department of Agriculture (USDA), provides a series of improved livestock production practices that could readily be implemented to reduce methane emissions from ruminant animals. The AgStar Program, developed by EPA, USDA, and U.S. Department of Energy, encourages the use of methane recovery technologies at confined animal feeding operations that manage manure as liquids or slurries to reduce methane emissions (U.S. EPA, 1997).

CALIFORNIA

The California Air Resources Board is responsible for enforcing the Federally-required SIP in an effort to achieve and maintain the national ambient air quality standards. In addition, CARB has established State Ambient Air Quality Standards (SAAQS) for the criteria pollutants (Table 4.2-1) as well as for other pollutants for which there are no corresponding Federal standards. The SAAQS for the criteria pollutants are equal to or more stringent than the Federal standards. CARB is responsible for assigning air basin attainment and nonattainment designations in California.

Analogous to the CAA and its amendments, the 1988 California Clean Air Act (CCAA) requires areas within the State to be designated as attainment or nonattainment with the SAAQS. The CCAA similarly requires that plans be prepared for nonattainment areas describing strategies to achieve the SAAQS.

The San Joaquin Valley is currently in nonattainment for the State ozone and PM\textsubscript{10} standards; the urbanized area of Fresno located within the San Joaquin Valley is also in nonattainment for the State carbon monoxide standard (SJVUAPCD, 1998). In 1991, the SJVUAPCD prepared an air quality attainment plan for the San Joaquin Valley to establish

\textsuperscript{2} The agreement was ratified by the U.S. Senate in October 1992 (Breidenich, 1999).

\textsuperscript{3} Ruminant animals have a four-chamber digestive system that converts otherwise unusable plant materials into nutritious food and fiber as well as methane; ruminant animals include cattle, sheep, buffalo, and goats.
the regulatory framework necessary to bring the San Joaquin Valley into compliance with the State ozone and carbon monoxide standards; this plan was last updated in 1994.4

SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

The San Joaquin Valley Air Basin includes all of San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare counties, and a portion of Kern County (SJUAPCD, 1998). The SJUAPCD was formed in 1992 and has jurisdiction over air quality issues in the San Joaquin Valley Air Basin; however, agricultural and livestock operations are exempt by State law from permitting requirements but are responsible for following prohibitory rules. The SVJUAPCD and CARB have joint responsibility for attaining and maintaining the State and Federal ambient air quality standards in the San Joaquin Valley Air Basin.

The San Joaquin Valley Unified Air Pollution Control District is currently working with CARB and other parties (i.e., industry) on the development of a comprehensive program of monitoring, emissions inventory development, data analysis, and modeling of particulate matter, specifically PM_{10} and PM_{2.5}. The purpose of the study is intended to provide an improved understanding of PM_{10} and PM_{2.5}, establish a strong scientific foundation for informed decision making, and to prepare efficient and cost-effective emission control strategies to achieve the PM_{10} and PM_{2.5} standards in central California. The study includes particulate matter associated with agricultural and livestock operations, including dairy facilities. The study is expected to be completed in 2003.

KINGS COUNTY

The Kings County Right-to-Farm Ordinance (Kings County Code of Ordinances, Chapter 14, Article III, Section 14-38) indicates that it is the County's policy to "protect agricultural land, operations, and facilities from conflicting uses due to the encroachment of incompatible, non-agricultural uses of the land in agricultural areas of the county," and to "advise developers, owners, and subsequent purchasers of property in the County of the inherent potential inconveniences and discomforts often associated with agricultural activities and operations, including, but not limited to, equipment and animal noise; farming activities conducted on a 24-hour a day, 7-day a week basis; odors from manure, fertilizers, pesticides, chemicals, or other sources; the aerial and ground application of chemicals and seeds; dust; flies and other insects; and smoke from agricultural operations."

The ordinance also indicates that no lawful agricultural activity, operation, or facility "conducted for commercial agricultural purposes in a manner consistent with proper and accepted customs and standards as established and followed by similar agricultural operations in the same

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4 Although the San Joaquin Valley is currently in nonattainment for the State PM_{10} standard, the SJUAPCD is currently not required to prepare a State Implementation Plan to attain the PM_{10} State standard.
locality, shall be or become a nuisance, private or public, due to any changed condition in or about the locality, including, but not limited to, the encroachment of non-agricultural uses such as rural residences. The ordinance requires that all approvals for rezonings, land divisions, zoning permits, and residential building permits in the County shall include a condition that notice and disclosure of this policy be given to subsequent owners and occupants of the property, and that transfers of property also include the notice.

AMBIENT AIR QUALITY

The San Joaquin Valley Air Basin is approximately 250 miles long and averages 35 miles in width. The width of the Valley in the area of the project site averages about 50 to 60 miles. It is the second largest air basin in California and has one of the most severe air pollution problems in the State. The following is a description of the sources, physical and health effects, and the air basin's attainment status, where appropriate, for air pollutants.

Ozone (O₃), also known as smog, is not emitted directly into the environment. Ozone is generated from complex chemical reactions that occur in the presence of sunlight. One of the primary components of the chemical reactions is nitrogen oxide (NOₓ), which is referred to as an ozone precursor. NOₓ generators in the San Joaquin Valley include mobile sources, solvents, and fuel combustion. Ozone exposure causes eye irritation and damage to lung tissue in humans. Ozone also harms vegetation, reduces crop yields, and accelerates deterioration of paints, finishes, rubber products, plastics, and fabrics. The San Joaquin Valley Air Basin is currently in nonattainment for the Federal and State standards for ozone.

Unlike ozone, carbon monoxide (CO) is released directly into the atmosphere by stationary and mobile sources. CO is an odorless, colorless gas formed by the incomplete combustion of fuels. CO combines with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood when inhaled at high concentrations. Only the urbanized area of Fresno is currently in nonattainment for the State CO standard. In 1998, the urbanized areas of Fresno, Stockton, Modesto, and Bakersfield were reclassified from nonattainment to attainment status for the Federal CO standard.²

PM₁₀ is released directly into the atmosphere by stationary and mobile sources. PM₁₀ consists of a wide range of solid and liquid particles, including smoke, dust, aerosols, and metallic oxides. Major sources of PM₁₀ include vehicles, power generation, industrial processing, wood burning, road dust, construction/farming activities, and fugitive

³ Based on personal communication between Mr. Joe O'Bannon of San Joaquin Valley Unified Air Pollution Control District and Ms. Rhodora Del Rosario of BASELINE Environmental Consulting on 10 March 1999.
windblown dust. The 1995 PM\textsubscript{10} emission inventory for the San Joaquin Valley Air Basin indicated that fugitive windblown dust, farming operations, and road dust were the three leading sources of PM\textsubscript{10} (SJVUAPCD, 1998). The San Joaquin Valley Air Basin is currently in nonattainment for the Federal and State PM\textsubscript{10} standards.

Like PM\textsubscript{10}, PM\textsubscript{2.5} is also released directly into the atmosphere by stationary and mobile sources. Sources of PM\textsubscript{2.5} include vehicles, power generation, industrial processes, and wood burning. The effects of PM\textsubscript{2.5} are similar to those of PM\textsubscript{10}. None of the air basins has been designated as attainment or nonattainment for the PM\textsubscript{2.5} standard due to the current lack of PM\textsubscript{2.5} data and the recent adoption of the PM\textsubscript{2.5} standard. As of the preparation of this EIR, the U.S. Court of Appeals for the District of Columbia Circuit has ruled that the new PM\textsubscript{2.5} standard was improperly adopted; the district is in the process of determining the course of action for PM\textsubscript{2.5}.

Ammonia and hydrogen sulfide are generated during anaerobic decomposition of manure. Ammonia can severely irritate the eye, ear, and throat at high concentrations. Ammonia reacts with nitrates and sulfates in the air to form ammonium nitrate, which is a particulate less than or equal to 2.5 microns. Hydrogen sulfide has a rotten egg odor and can cause dizziness, respiratory tract irritation, nausea, and headaches at low concentrations. Ammonia does not have Federal or State standards but is a precursor of PM\textsubscript{2.5}. Hydrogen sulfide has a State standard but the San Joaquin Valley is unclassified in attainment status.

Methane is an odorless greenhouse gas that absorbs and reflects terrestrial radiation back to the earth, potentially causing the earth surface temperature to gradually increase (U.S.EPA, 1995). Methane is emitted into the environment from various sources, including ruminant livestock and manure decomposition. Methane released from domesticated ruminant livestock accounts for about 20 percent (about 80 million metric tons per year) of the anthropogenic methane generated in the United States (Agricultural Education, University of Missouri, et al., 1998; U.S. EPA, 1998a).

Of the ruminant livestock, dairy cattle generate about 1.5 million metric tons of methane per year, or about two percent of the total ruminant livestock methane generated and only about 0.4 percent of the total anthropogenic methane generated in the United States (U.S. EPA, 1998a). Ruminant animals produce methane emissions as part of their special digestive process. A portion of the feed material is converted into energy needed to support the maintenance and production (e.g., body tissue growth, milk, reproduction) of the animal. Feed that is not transformed into maintenance and production energy is

\footnote{Other anthropogenic sources of methane include landfills, natural gas and petroleum systems, rice cultivation, agricultural residue burning, coal mining, and fossil fuel production (U.S. EPA, 1998a).}
converted into methane as a by-product. Methane generation from dairy cattle is influenced by feed quality, essential nutrients in the feed, feeding level and schedule, and animal health. Methane is released through the animal’s mouth and nostrils.

Methane is also generated from anaerobic decomposition of livestock manure. Approximately 26 million metric tons per year of methane are generated from livestock manure in the United States, about seven percent of the total anthropogenic methane generated in the United States (Agricultural Education, University of Missouri, et al., 1998). The remaining major anthropogenic methane sources, producing 73 percent of methane emissions, are rice farming, natural gas/petroleum use, coal mining, biomass burning, landfills, and publicly owned wastewater treatment systems.

Reactive organic gases (ROG) are also generated during decomposition of manure. ROG consist of hydrocarbons that undergo photochemical reactions to form ozone and are considered ozone precursors. The San Joaquin Valley is in nonattainment for both Federal and State ozone standards.

The nearest permanent air quality monitoring stations to the project site are the Van Dorsten, Patterson, and Hanford stations. The Van Dorsten Avenue and Patterson stations in Corcoran are located approximately 7.0 miles southeast of the project site; the two stations are located within 1.0 mile of each other. The Patterson station was opened in 1996 to replace the Van Dorsten Avenue station; the criteria pollutant monitored at the two stations is PM$_{10}$. The Hanford station is located approximately 9.0 miles northeast of the project site; the criteria pollutants monitored at the Hanford station are PM$_{10}$, ozone, and nitrogen dioxide. The air quality data for the last three available years (1995 to 1997) are summarized in Table 4.2-2.

**AVAILABLE MANURE TREATMENT TECHNOLOGIES**

Animal manure will naturally undergo anaerobic decomposition (Westerman and Zhang, 1996). A wide variety of gaseous compounds are created and released into the environment at various stages of the decomposition process, including reactive organic gases, methane, carbon dioxide, ammonia, and hydrogen sulfide, some of which are odorous (i.e., ammonia, hydrogen sulfide, and reactive organic gases). Several technologies have been developed to control emissions and odors generated from manure decomposition. These technologies include biological additives, chemical additives,
permeable and impermeable covers, natural crust formed cover, composting, aerobic\textsuperscript{8} treatment systems, and anaerobic digestion.\textsuperscript{9}

**TABLE 4.2-2: Summary of Air Quality Data, 1995-1997**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Van Dorsten and Patterson Stations</th>
<th>Hanford Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM\textsubscript{10}</td>
<td>State 24-hours (50 μg/m\textsuperscript{3})</td>
<td>Days over standard</td>
<td>24\textsuperscript{1} 17/6 16/15</td>
</tr>
<tr>
<td>Federal 24-hours (150 μg/m\textsuperscript{3})</td>
<td>Days over standard</td>
<td>2\textsuperscript{1} 0/0 1/1</td>
<td></td>
</tr>
<tr>
<td>State annual geometric mean (30 μg/m\textsuperscript{3})</td>
<td>Annual geometric mean concentration (μg/m\textsuperscript{3})</td>
<td>39.9\textsuperscript{4} 35.4/37.3 40.0/42.3</td>
<td></td>
</tr>
<tr>
<td>Federal annual arithmetic mean (50 μg/m\textsuperscript{3})</td>
<td>Annual arithmetic mean concentration (μg/m\textsuperscript{3})</td>
<td>51.5\textsuperscript{1} 41.0/52.0 44.8/48.1</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- \(\mu g/m^3\) = micrograms per cubic meter.
- xx/yy = Van Dorsten Avenue data/Patterson data.
- Values in parentheses indicate corresponding standard.

1 Values available only for Van Dorsten Avenue.

**Biological Waste Supplements**

Biological waste supplements may be applied to a manure collection area in an attempt to reduce hydrogen sulfide and ammonia gas generation. The supplements are intended to enhance bacteria growth, including sulfur reducing bacteria. However, this technology has been identified to be questionable (MPCA, 1999). This technology also does not address

\[\text{Aerobic decomposition occurs in the presence of oxygen.}\]

\[\text{It should be noted that the technologies described in this air quality analysis are summaries of the most common technologies that address some of the gases generated by manure decomposition.}\]

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4.2 Air Quality

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the reduction of methane or reactive organic gases generated from natural anaerobic decomposition of the manure.

Chemical Additives
The primary purpose of chemical additives is to mask and counteract odors generated from anaerobic decomposition. Additives such as lime may be added to increase the pH of the manure and reduce hydrogen sulfide emissions. However, the rate of ammonia gas generation increases with elevated pH levels. This technology does not address the reduction of other gases generated from natural anaerobic decomposition of the manure.

Permeable and Impermeable Covers
Several types of impermeable and permeable covers have been developed for placement over manure storage systems such as holding ponds; covers act as a physical barrier between liquid manure and the air. Permeable covers (known as biocovers) typically consist of an 8- to 12-inch wheat or barley straw layer (or other type of organic layer) lined with geotextile fabric; this type of cover acts as a biofilter and reduces the odor-related emissions such as ammonia and hydrogen sulfide (Jacobson, et al., 1998; MPCA, 1999). However, this type of permeable cover would not prevent emission of other gases (i.e., methane) generated from the anaerobically decomposing manure contained in the waste storage system (Sullivan, 1999).

Impermeable covers have been used to retain gases generated from manure waste storage systems. However, gases generated (methane, reactive organic compounds, ammonia, hydrogen sulfide) from natural anaerobic decomposition of the stored manure must be treated to remove air pollutants before being emitted into the environment. Treatment may include a biofilter and/or flare; therefore, the impermeable covers would need to be equipped with a gas collection system, similar to a covered lagoon anaerobic digester.

Biofilters would capture and reduce odor-related compounds (e.g., ammonia and hydrogen sulfide) but are not expected to reduce methane emissions (MPCA, 1999; Sullivan, 1999). Burning gases (collected from the covers by flaring) generate combustion gases; as a result, ozone precursor gases and carbon monoxide would be generated.

Natural Crust Formed Cover
Stored dairy manure can form a natural crust layer cover, depending on factors such as solids content, holding storage surface area, feed type, and weather conditions (Sullivan, 1999; Jacobson, et al., 1998). For instance, the tendency for a crust layer to form is reduced with increasing storage surface area and decreasing solids content. At least two to three years of operation are typically required before a crust layer can form (Sullivan, 1999). The
effectiveness of natural crust layers is similar to that of impermeable covers discussed above. However, minimal agitation, which is typically inevitable, of a crust layer would release gases formed within the system; in addition, non-odorous gases, such as methane, may escape through the crust layer. Furthermore, the Kings Mosquito Abatement District (undated) prohibits the formation of natural crusts on dairy process water lagoons.

**Composting**

Manure composting is a biological treatment process conducted ideally under aerobic conditions (Clanton, 1997). Composting is commonly used for manure with solids content of at least 25 to 30 percent (Bicudo, 1999); raw dairy manure typically contains 14 to 16 percent solids (U.S. EPA, 1999). However, carbon sources (e.g., straw) may be added to raw manure to increase the solids content of the manure. Composting of flushed manure, common at dairy facilities, would not be appropriate due to the low solids content.

Composting requires the continuous aeration of the system for the aerobic process to continue; otherwise, waste could undergo anaerobic decomposition, generating methane and other gases (Richard, 1996). Aeration can be affected by forced aeration mechanical systems or passive aerated systems, which depend on diffusion and natural convection to aerate the waste. Land availability is a major limitation for composting. For instance, passive aerated windrows typically are three to nine feet in height and six to 18 feet in width (double the height). For forced aeration systems, the ideal windrow size will depend on the characteristics of the manure being composted; typically, the maximum height of a compost pile is from six to nine feet. Therefore, both systems require large areas to feasibly and appropriately handle manure; this technology would likely be inappropriate for dairies generating large volumes of scraped manure on a daily basis.

The composting process will result in the elimination or reduction of methane, hydrogen sulfide, and reactive organic gases compared to natural anaerobic decomposition of manure; however, ammonia emissions would be released into the environment. Equipment operations needed for the composting process would generate exhaust emissions. In addition, composting requires pretreatment of the manure such as sorting, mixing, grinding, temporary storage, and amendment addition (Clanton, 1999); these operations may cause air pollutants (e.g., methane, reactive organic gases, ammonia, hydrogen sulfide) to be released into the environment if anaerobic decomposition of the manure were to occur while the manure was being stored.

**Aerobic Treatment Systems**

Aerobic treatment is a process that enhances the decomposition of livestock manure slurries by aerobic bacteria with the addition of oxygen, thus preventing anaerobic decomposition. Various aerobic treatment systems have been used for managing livestock...
manure slurries, including activated sludge reactors, aerated lagoons, and oxidation ditches (Westerman and Zhang, 1996). Depending on the system, mechanical aerators may be used to enhance oxygen transfer to the waste liquid or diffused air may be introduced within the treatment volume. Various mechanical aerators include compressed air, mechanical surface, mechanical subsurface, combined compressed air/mechanical, and pumped liquid aerator.

Aerobic treatment systems would reduce or prevent the generation of hydrogen sulfide, reactive organic gases, and methane. End products from aerobic systems are carbon dioxide, water, sulfates, and nitrates; however, ammonia emissions would continue to be emitted into the environment, depending on the pH (Zanderghynst, 1999; Brady, 1990).

The liquid and solid effluent may be applied to land provided that the manure is completely stabilized; otherwise, anaerobic decomposition would occur and result in the generation and release of various gases including hydrogen sulfide, reactive organic gases, and methane. The main disadvantage of aerobic treatment is the high energy costs required to continuously aerate the treatment volume sufficiently (Westerman and Zhang, 1996).

Aerobic treatment systems have recently been used at two dairy facilities in the San Joaquin Valley, one in Kings County and the other in Kern County. The aerobic treatment system in Kings County was a six-month pilot study conducted at the Longfellow Dairy in Hanford; the study was conducted by Rain for Rent, Mazzei Injector Corporation, University of California at Davis, and the University of California Cooperative Extension Service. The treatment system was designed to handle approximately 5,000 gallons per day of flushed manure. The system consisted of a solids separator, two treatment tanks equipped with aerators (two stage treatment), and an effluent storage basin. Flushed manure was effectively treated to eliminate the potential generation of ammonia gases. However, although the treatment would reduce the total suspended solids of the manure, periodic clearing of the system would be needed to remove eventual solids accumulation in the tanks (Grundvig, 1999). 10

The aerobic treatment system in Kern County was constructed in May 1999 and is currently being operated to treat flushed dairy manure. The system was installed at the Visser Dairy located in McFarland, which handles approximately 3,000 cows. The system requires continuous maintenance and consists of two treatment ponds equipped with aerators and agitators and a storage pond. Microbes are also added to the treatment ponds to aid in the aerobic digestion of the manure. Similar to the pilot study performed in Kings County, the

10 The system was not monitored to evaluate the releases of hydrogen sulfide, reactive organic gases, or methane. However, these gases are not typically generated under aerobic conditions.
process water was effectively treated to eliminate the potential generation of ammonia gases. Treated effluent, a liquid slurry, is currently applied on agricultural fields (Lubin, 1999)."11

Anaerobic Digester Systems

Anaerobic digestion is an enclosed and controlled biological waste treatment process that is conducted in the absence of oxygen. The process includes capturing biogases generated from anaerobic digestion (methane, carbon dioxide, and trace gases such as hydrogen sulfide and ammonia) to minimize or prevent release into the environment. Reactive organic gases would also be minimized since the organic compounds would remain in liquid phase (due to the limited head space in the fully enclosed system) and eventually be converted into the biogases (Zhang, 1999).

The three basic types of anaerobic digesters operated in the United States are covered lagoons, plug flow digesters, and complete mix digesters. A covered lagoon is a fully enclosed lagoon, which typically is designed to have a retention time of 50 to 60 days; the lagoon design is similar to that of a dairy holding pond, but on a smaller scale (Sharp, 1999). Complete mix and plug flow digesters are designed and operated to enhance anaerobic decomposition and typically require less land area than lagoon systems. Selection of the appropriate digester system would depend on numerous factors such as, but not limited to, climate, manure solids content, solids characteristics, and land availability.

The biogases generated from anaerobic digester systems may be converted into electricity for on-site use or resale. Biogases may also be used directly as a fuel for a boiler to produce steam for facility operations.

Solid effluent, which is stable and rich in nutrients (ammonia, phosphorous, and potassium) is generated from the digester process; the effluent may be used for crop irrigation. In addition, the solids are an excellent soil conditioner, and may be used as a livestock feed additive when dried (U.S. DOE, undated). However, effluent would have the potential to release ammonia during storage and application. In addition, operation of the anaerobic digester treatment system would generate exhaust emissions from fuel-operated equipment and from burning of the biogas.

The AgStar Program promotes the development and operation of biogas systems (e.g., anaerobic digester treatment systems) at commercial farms (e.g., dairy, swine, and poultry)

11 The system was also not monitored to evaluate the releases of hydrogen sulfide, reactive organic gases, or methane. However, these gases are not typically generated under aerobic conditions.
in the United States to reduce air pollutant emissions. However, installation of a biogas system at dairy facilities has not been considered to be a practical solution to reducing the methane generated from dairy manure because of the cost to design and construct the system as well as the labor required to maintain and operate it.\(^\text{12}\)

A survey conducted in 1995 (Morse, et al., 1995) identified six dairy producers in California who had operated anaerobic digester systems as part of their dairy manure management systems. The installation costs for the digesters ranged from $100,000 to $950,000, generally increasing with the size of the dairy herd, which ranged from 200 to 1,500 cows. Of those dairies, only one continued to operate the digester. Three had discontinued use of the digester system, and the other two no longer operated their dairies. Producers who discontinued use of the digesters indicated that operational problems and maintenance costs were significant problems. In addition, the differential between the price dairy producers paid electrical companies for electricity and the price electrical companies paid for electricity generated at the dairies from biogas fueled turbines created additional economic problems. The results of the survey indicated that the economical feasibility of operating digesters in California was marginal in 1995 but that correction of operational problems and establishment of a trained service industry for operating digesters could promote their use as a viable component of dairy manure management systems.

**EXISTING CONDITIONS AT PROJECT SITE**

The project site is located on contiguous parcels of land in Kings County, approximately 45 miles south of Fresno, midway between the cities of Hanford and Corcoran in Kings County (Figure 3-1). The project site is 5,915 acres and is currently used for agriculture; cotton, wheat, corn, and other row crops are being grown on the project site. Existing sources of air pollutant emissions from agricultural activities include fugitive dust from land preparation, crop harvesting, and fugitive windblown dust; and agricultural equipment exhaust emissions.

**PM\(_{10}\) Emissions from Fugitive Dust**

PM\(_{10}\) emissions from fugitive dust are released into the atmosphere during land preparation for planting and post-harvest activities. Typical land preparation operations include stubble disking, finish disking, mulching, and other mechanical disturbances. Soil preparation activities are dependent on the crop type being grown. Typically, land preparation for cotton occurs from October through April; corn land preparation occurs

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\(^{12}\) Based on personal communication between Mr. Tom Shultz, Farm Advisor with the University of California Cooperative Extension (Tulare County) and Rhodora Del Rosario, P.E., of BASELINE Environmental Consulting on 6 May 1999.
from November through March; and wheat land preparation occurs in November and December (CARB, undated a).

Land preparation activities at the project site could generate up to 32 tons per year of \( \text{PM}_{10} \) emissions. The proposed dairy facilities would be completely located on the project site. Dairy units A, B, C, and D would encompass 960, 1,116, 2,399, and 1,440 acres, respectively. Of the 32 tons per year of \( \text{PM}_{10} \) emissions, up to 5 tons per year could be generated from current land preparation activities on the Dairy A unit footprint area. Similarly, 7, 10, and 9 tons per year of \( \text{PM}_{10} \) emissions could be generated from current land preparation activities on Dairies B, C, and D footprint areas, respectively (Tables 4.2-4a through 4.2-4e). The estimates were based on emission factors developed by CARB for the current crops produced on the project site (cotton, wheat, and corn) and the crop planting area (CARB, 1997b).\(^{13}\)

Windblown dust across agricultural fields also releases \( \text{PM}_{10} \) emissions to the environment. Up to 37 tons per year of \( \text{PM}_{10} \) emissions could be released due to windblown dust at the project site; of this amount, up to 6 tons per year could be generated from current land preparation activities on the Dairy A unit footprint area. Similarly, 7, 15, and 9 tons per year of \( \text{PM}_{10} \) emissions could be generated from windblown dust on the Dairy B, C, and D unit footprint areas, respectively (Tables 4.2-4a through 4.2-4e). The estimated emissions were based on the size of the current agricultural field (5,915 acres) and the CARB-developed emission factor for soil conditions in Kings County for nonpasture lands (CARB, 1997c).

Crop harvesting activities would also generate \( \text{PM}_{10} \) emissions from current operations. However, emission factors are only available for cotton; therefore, \( \text{PM}_{10} \) emissions from crop harvesting are not estimated.

**Agricultural Equipment Exhaust Emissions**

Air pollutant emissions from agricultural equipment exhaust include ozone precursors (i.e., ROG and NOx) and \( \text{PM}_{10} \). ROG, NOx, and \( \text{PM}_{10} \) emissions generated from agricultural equipment were estimated based on site specific data regarding equipment types and duration as well as emission factors and load factors developed by CARB for farm

\(^{13}\) Dust emissions calculated for land preparation were reduced by 25 percent for the months of December and March, as suggested by CARB; similarly, dust emissions calculated for January and February were reduced by 50 percent to reflect a typical seasonal decrease in land preparation activities and conditions that are more consistent with ambient air dust levels at that time.
equipment (CARB, 1995). Estimated ROG, NOx, and PM10 emissions generated at the project site from current operations are calculated to be 0.9, 12.1, and 0.6 tons per year, respectively (Tables 4.2-4a through 4.2-4e).

EXISTING CONDITIONS NEAR PROJECT SITE

The project site is surrounded by agricultural land uses including poultry and dairy facilities and rural farm residences (Figure 4.7-1). Five poultry facilities are located near the project site, at distances of approximately 175 feet to 1.7 miles from the project site. A dairy facility (Machado Dairy) is located approximately 1.8 miles northeast of the project site. Nuisance complaints for the Machado Dairy have not been recorded by SJVUAHDC since 1992 (SJVUAHDC, 1999). However, the SJVUAHDC does not document complaints since SJVUAHDC’s odor nuisance rule does not apply to agricultural operations associated with growing crops or raising fowl or animals. During the period September 1996 through September 1999, the Kings County Department of Public Health received a total of eight complaints regarding dairy facilities. Five of the complaints related to the management of process water and/or flies. The remaining three complaints related to odors at one dairy facility (Tucker, 1999).

RECEPTORS

Receptors are generally regarded to be people exposed to air emissions generated by development construction and operation. The SJVUAHDC defines a “sensitive receptor” as a location where human populations, especially children, seniors, and sick persons are present, and where there is a reasonable expectation of continuous human exposure to pollutants, according to the averaging period for the ambient air quality standards, such as 24-hour, 8-hour, or 1-hour. Examples of receptors include residences, hospitals, and schools (SJVUAHDC, 1998). Although the SJVUAHDC definition of receptors includes residences, it is generally interpreted to include areas designated by the General Plan for residential use. The proposed project site is located in a rural area were residences are generally isolated and surrounded by large agricultural fields. Receptors in such agricultural areas are subject to the Right-to-Farm Ordinance and are expected to be subject to discomfort and inconveniences caused by air emissions associated with standard agricultural operations or practices.

Potential receptors near the project site include rural farm residences, including mobile homes. A rural farm residence and two mobile homes are located from 0.33 to 0.8 mile northwest of the project site, north of Laurel Avenue; the rural farm residence is located

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14 Load factors were obtained from the 1996 Power Systems Research database; this information was obtained in personal communications between Ms. Debbie Lum of the California Air Resources Board and Ms. Rhodora Del Rosario of BASELINE Environmental Consulting on 2 March 1999.
at a poultry facility. Rural residences and mobile homes are located north of the project site, between 0.75 and 1.5 miles from the northern project boundary. Rural farm residences are also located northeast of the project site, between 1.5 and 2.25 miles from the northeastern project boundary. Similarly, three rural residences are located east of the project site, at distances of 175 feet to 1.0 mile from the southeast project boundary.

IMPACTS AND MITIGATION MEASURES

CONSISTENCY WITH PLANS AND POLICIES

The Air Quality section of the Resources Conservation Element of the Kings County General Plan does not contain specific goals, objectives, or policies related to air quality pollutants that would be relevant to the proposed project. The main goal of the General Plan is to protect human health and preserve the environment by achieving good air quality.

Goal 13: Protect human health and preserve the environment by achieving good air quality.

Objective 13.1: Implement air quality standards that protect human health and prevent crop, plant, and property damage.

Policy 13b: Require that commercial and industrial development minimize air pollution emissions by using Best Available Control Technology (BACT).

Policy 13c: Refer development projects to the San Joaquin Valley Unified Air Pollution Control District as appropriate for their review and comment. Consider their suggestions and requirements as conditions of approval.

The proposed project may not be consistent with the General Plan's main goal since air pollutants would be released into the environment at levels that would exceed significance thresholds established by the SJVUAPCD, as discussed in the impacts discussions below. It should be noted that, although Policy 13c indicates that development projects should be referred to the SJVUAPCD as appropriate for their review and comment, agricultural and livestock operations, such as the proposed project, are exempt from the permitting requirements of SJVUAPCD.

SIGNIFICANCE CRITERIA

Based on the recently amended environmental checklist in the CEQA Guidelines (Appendix G), a project could have a potentially significant air quality impact on the environment if it would:
• conflict with or obstruct implementation of air quality plan;
• violate ambient air quality standards or contribute substantially to an existing or projected air quality violation;
• result in a cumulatively considerable net increase of any criteria pollutant for which the project region is in nonattainment under Federal or State standards;
• expose receptors to substantial pollutant concentrations; or
• create objectionable odors affecting a substantial number of people.

An impact resulting from construction activities would also be considered significant if feasible construction control mitigation measures identified in SJVUAPCD’s Guide for Assessing and Mitigating Air Quality Impacts (guidelines) were not implemented.

According to SJVUAPCD guidelines, a project could also have a significant air quality impact on the environment if project operations have the potential to frequently expose members of the public to objectionable odors; the SJVUAPCD has indicated that dairies located within 1.0 mile of a sensitive receptor could generate odors that may be significant (SJVUAPCD, 1998).

The SJVUAPCD has established thresholds for certain criteria pollutants for determining whether a project’s operation would have a significant air quality impact (Table 4.2-3). In general, if any of the estimated ROG, NOx, and CO emissions generated from a project exceeds the thresholds, the project would be considered to have a significant air quality impact. The thresholds established by the SJVUAPCD are used in this air quality analysis as criteria for determining significant environmental impacts.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Threshold of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROG</td>
<td>10 tons per year</td>
</tr>
<tr>
<td>NOx</td>
<td>10 tons per year</td>
</tr>
<tr>
<td>CO</td>
<td>9 ppm (8-hour average)</td>
</tr>
<tr>
<td></td>
<td>20 ppm (1-hour average)</td>
</tr>
<tr>
<td>PM_{10}</td>
<td>15 tons per year</td>
</tr>
</tbody>
</table>

Notes: ROG = Reactive organic gas
NOx = Oxides of nitrogen
PM_{10} = Particulate matter with a diameter less than or equal to ten microns
ppm = parts per million
SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District

Refer to text for discussion of the applicability of these thresholds to emissions from the proposed project.

The PM_{10} emission threshold level (15 tons per year or 80 pounds per day) is the designated “offset” value specified in the SJVUAPCD permit conditions. An offset value is the maximum allowed pollutant emission rate an owner/operator of a source can release into the environment. If an owner/operator intends to release PM_{10} emissions at a rate greater than the offset value, the owner/operator must identify how the excess emissions would be offset, which is typically done by “purchasing” emission credits from a former PM_{10} emission source. Although SJVUAPCD has not included a significance threshold value for PM_{10} in their guidelines, the offset value of 15 tons per year has been defined as a significance criterion for this air quality analysis.
Local air emissions can have cumulative global impacts. For example, worldwide halocarbon (a class of compounds containing chlorine and/or fluorine) emissions have been linked to ozone depletion in the upper atmosphere. Similarly, worldwide greenhouse gas emissions have also been linked to the gradual increase in near-surface temperatures. Methane is the second most significant gas causing increases in greenhouse gases (after carbon dioxide). Therefore, emissions that contribute to a global adverse environmental condition are also considered to be a significant impact in this air quality analysis.

**IMPACTS ANALYSIS APPROACH**

The proposed project would generate construction-related and project operation-related emissions. Construction-related emissions would include PM$_{10}$ emissions from fugitive dust generated during soil movement activities; and exhaust emissions (e.g., ROG, NOx, and PM$_{10}$) from construction equipment. Construction-related impacts are addressed in 4.2-1 and 4.2-2. Project operations would also generate air pollutant emissions, including ROG, NOx, PM$_{10}$, ammonia, hydrogen sulfide, carbon monoxide, and methane. The following is a list of the air pollutant emissions and the corresponding sources generated from project operations:

- PM$_{10}$ emissions from fugitive dust generated during agricultural activities (e.g., land preparation and windblown dust) and dairy operations;
- Exhaust emissions (ROG, NOx, PM$_{10}$) from dairy and agricultural equipment;
- ROG, hydrogen sulfide, ammonia, and methane emissions from manure decomposition;
- Methane emissions from cattle digestion; and
- Localized (CO) and regional emissions (ROG, NOx, PM$_{10}$) from motor vehicle use associated with the project.

Tables 4.2-4a to 4.2-4d identify the emissions generated from each project operation source and provide the total net increase in emissions from project operations at each dairy unit; Table 4.2-4e identifies the total project operation and total net increase in emissions for all the dairy units combined. In addition to air pollutant emissions, project operations would also generate adverse odor.
### TABLE 4.2-4a: Total Emissions from Project Operations at Dairy A Unit

<table>
<thead>
<tr>
<th>Activity</th>
<th>ROG</th>
<th>NOₓ</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Windblown Dust</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Subtotal</td>
<td>-</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Exhaust, Agricultural Equipment</td>
<td>0.2</td>
<td>2.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

| Proposed Project | | | |
| Fugitive Dust (Impact 4.2-3) | | | |
| Land Preparation | - | - | 3 |
| Windblown Dust | - | - | 6 |
| Cattle Movement at Unpaved Corral | - | - | 42 to 89¹ |
| Unpaved Road Dust | - | - | 4 |
| Subtotal | - | - | 55 to 102 |
| Exhaust, Agricultural and Dairy Equipment (Impact 4.2-4) | 0.5 | 6.7 | 0.4 |
| Manure Decomposition (Impacts 4.2-6, 4.2-7, 4.2-9) | 54 | - | 77 |
| Cattle (Impact 4.2-9) | - | - | 703 |
| Regional Emissions, Vehicular Traffic (Impact 4.2-11) | 0.19 | 0.97 | 0.02 |

| Net Emissions Increase | | | |
| Fugitive Dust | - | - | 44 to 91 |
| Exhaust, Agricultural and Dairy Equipment | 0.3 | 4.7 | 0.3 |
| Manure Decomposition | 54 | - | 77 |
| Cattle | - | - | 703 |
| Regional Emissions, Vehicular Traffic | 0.19 | 0.97 | 0.02 |
| Total Net Increase | 54.49 | 5.67 | 44.32 to 91.32 |

| Significance Threshold | 10 | 10 | 15 |

### Notes:
- ROG = Reactive organic gases
- NOₓ = Nitrogen oxides
- PM₁₀ = Particulate matter with an aerodynamic diameter of less than or equal to ten microns
- = Not applicable
- Bold values under the Net Emissions Increase section indicate emission exceeds significance threshold.

See Appendix B for air quality calculations.

Hydrogen sulfide emissions are not included since an emission factor for hydrogen sulfide from manure decomposition could not be found and, therefore, hydrogen sulfide emissions could not be calculated. Calculation of carbon monoxide emissions generated from additional vehicular traffic were not necessary, based on SJVUAPCD guidelines (See Impact 4.2-9).

PM₁₀ emission factors from dust generated at unpaved corrals are currently unavailable from U.S. EPA or CARB. The PM₁₀ emission factor from dust generated at cattle feedlots was selected to conservatively estimate PM₁₀ emissions generated at unpaved corrals as the PM₁₀ emission factor for cattle feedlot is currently the most applicable factor available by U.S. EPA and CARB; actual PM₁₀ emissions generated at unpaved corrals would be expected to be less than the estimated emissions since cattle feedlots are known to generate more PM₁₀ emissions than unpaved corrals. The lower PM₁₀ emission value accounts for rainfall effects and neglects PM₁₀ emissions generated from calves and baby calves; the higher PM₁₀ emission value ignores rainfall effects and assumes PM₁₀ emission rates from calves and baby calves are equivalent to heifers and dry cows.

Kings County
15 October 1999
92225b.001 4.2-20

CHAMBERLAIN RANCH PROJECT
4.2 Air Quality

001549

007961
### TABLE 4.2-4b: Total Emissions from Project Operations at Dairy B Unit

<table>
<thead>
<tr>
<th>Existing Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fugitive Dust</td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td></td>
</tr>
<tr>
<td>Windblown Dust</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
</tr>
<tr>
<td>Exhaust, Agricultural Equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>Proposed Project</td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust (Impact 4.2.3.3)</td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td>--</td>
</tr>
<tr>
<td>Windblown Dust</td>
<td>--</td>
</tr>
<tr>
<td>Cattle Movement at Unpaved Corral</td>
<td>--</td>
</tr>
<tr>
<td>Unpaved Road Dust</td>
<td>--</td>
</tr>
<tr>
<td>Subtotal</td>
<td>--</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment (Impact 4.2-4)</td>
<td>0.6</td>
</tr>
<tr>
<td>Manure Decomposition (Impacts 4.2-6, 4.2-7, 4.2-9)</td>
<td>63</td>
</tr>
<tr>
<td>Cattle (Impact 4.2-9)</td>
<td>--</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic (Impact 4.2-11)</td>
<td>0.23</td>
</tr>
<tr>
<td>Net Emissions Increase</td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td>--</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment</td>
<td>0.4</td>
</tr>
<tr>
<td>Manure Decomposition</td>
<td>63</td>
</tr>
<tr>
<td>Cattle</td>
<td>--</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic</td>
<td>0.23</td>
</tr>
<tr>
<td>Total Net Increase</td>
<td>63.63</td>
</tr>
<tr>
<td>Significance Threshold</td>
<td>10</td>
</tr>
</tbody>
</table>

**Notes:** See Table 4.2-4a
TABLE 4.2-4c: Total Emissions from Project Operations at Dairy C Unit

<table>
<thead>
<tr>
<th>Activity</th>
<th>Existing Conditions</th>
<th>Proposed Project</th>
<th>Notes: See Table 4.2-4a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fugitive Dust</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td>- - 10</td>
<td>Fugitive Dust (Impact 4.2-3)</td>
<td></td>
</tr>
<tr>
<td>Windblown Dust</td>
<td>- - 15</td>
<td>Land Preparation</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>- - 25</td>
<td>Windblown Dust</td>
<td></td>
</tr>
<tr>
<td>Exhaust, Agricultural Equipment</td>
<td>0.3 4.6 0.2</td>
<td>Cattle Movement at Unpaved Corral</td>
<td></td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment (Impact 4.2-4)</td>
<td>0.7 9.4 0.5</td>
<td>Unpaved Road Dust</td>
<td></td>
</tr>
<tr>
<td>Manure Decomposition (Impacts 4.2-6, 4.2-7, 4.2-9)</td>
<td>143 -- 203 1,247</td>
<td>Subtotal</td>
<td></td>
</tr>
<tr>
<td>Cattle (Impact 4.2-9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic (Impact 4.2-11)</td>
<td>0.51 2.57 0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Emissions Increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td>- - 113 to 239</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment</td>
<td>0.4 4.8 0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure Decomposition</td>
<td>143 -- 203 1,247</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>-- -- --</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic</td>
<td>0.51 2.57 0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Net Increase</td>
<td>143.91 7.37 113.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance Threshold</td>
<td>10 10 15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 4.2-4d: Total Emissions from Project Operations at Dairy D Unit

<table>
<thead>
<tr>
<th></th>
<th>Existing Conditions</th>
<th>Proposed Project</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fugitive Dust (Impact 4.2-3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Preparation</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Windblown Dust</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
<td>18</td>
</tr>
<tr>
<td>Exhaust, Agricultural Equipment</td>
<td>0.2</td>
<td>3.1</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proposed Project</td>
<td>Fugitive Dust (Impact 4.2-3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Preparation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Windblown Dust</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cattle Movement at Unpaved Corral</td>
<td>62 to 134</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unpaved Road Dust</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtotal</td>
<td>79 to 151</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment (Impact 4.2-4)</td>
<td>0.6</td>
<td>7.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Manure Decomposition (Impacts 4.2-6, 4.2-7, 4.2-9)</td>
<td>82</td>
<td>--</td>
<td>116</td>
</tr>
<tr>
<td>Cattle (Impact 4.2-9)</td>
<td>--</td>
<td>--</td>
<td>1,058</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic (Impact 4.2-11)</td>
<td>0.29</td>
<td>1.40</td>
<td>0.03</td>
</tr>
<tr>
<td>Net Emissions Increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td>--</td>
<td>--</td>
<td>61 to 133</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment</td>
<td>0.4</td>
<td>4.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Manure Decomposition</td>
<td>82</td>
<td>--</td>
<td>116</td>
</tr>
<tr>
<td>Cattle</td>
<td>--</td>
<td>--</td>
<td>1,058</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic</td>
<td>0.29</td>
<td>1.40</td>
<td>0.03</td>
</tr>
<tr>
<td>Total Net Increase</td>
<td>82.69</td>
<td>6.10</td>
<td>61.23</td>
</tr>
<tr>
<td></td>
<td>to 133.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance Threshold</td>
<td>10</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

**Notes:** See Table 4.2-4a
TABLE 4.2-4c: Total Emissions from Project Operations at All Dairy Units

<table>
<thead>
<tr>
<th>Activity</th>
<th>Existing Conditions</th>
<th>Proposed Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Windblown Dust</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Subtotal</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Exhaust, Agricultural Equipment</td>
<td>0.9</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Proposed Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust (Impact 4.2-3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land Preparation</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Windblown Dust</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Cattle Movement at Unpaved Corral</td>
<td>--</td>
<td>261 to 561</td>
</tr>
<tr>
<td>Unpaved Road Dust</td>
<td>--</td>
<td>24</td>
</tr>
<tr>
<td>Subtotal</td>
<td>--</td>
<td>335 to 635</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment (Impact 4.2-4)</td>
<td>2.4</td>
<td>30.9</td>
</tr>
<tr>
<td>Manure Decomposition (Impacts 4.2-6, 4.2-7, 4.2-9)</td>
<td>342</td>
<td>486, 2,991</td>
</tr>
<tr>
<td>Cattle (Impact 4.2-9)</td>
<td>--</td>
<td>4,428</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic (Impact 4.2-11)</td>
<td>1.22</td>
<td>6.04</td>
</tr>
<tr>
<td></td>
<td>0.13</td>
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</tr>
<tr>
<td>Net Emissions Increase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fugitive Dust</td>
<td>--</td>
<td>267 to 567</td>
</tr>
<tr>
<td>Exhaust, Agricultural and Dairy Equipment</td>
<td>1.5</td>
<td>18.8</td>
</tr>
<tr>
<td>Manure Decomposition</td>
<td>342</td>
<td>486, 2,991</td>
</tr>
<tr>
<td>Cattle</td>
<td>--</td>
<td>4,428</td>
</tr>
<tr>
<td>Regional Emissions, Vehicular Traffic</td>
<td>1.22</td>
<td>6.04</td>
</tr>
<tr>
<td></td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Total Net Increase</td>
<td>344.72</td>
<td>24.84, 268.23</td>
</tr>
<tr>
<td></td>
<td>486</td>
<td>7,419</td>
</tr>
<tr>
<td></td>
<td>to 568.23</td>
<td></td>
</tr>
<tr>
<td>Significance Threshold (four times significance threshold for individual project)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

Notes: See Table 4.2-4a.
Impact 4.2-1
Increases in PM$_{10}$ emissions during construction. This is a significant impact.

Construction activities associated with development of the four dairy facilities would include site preparation, soil excavation, grading, equipment traffic on paved and possibly unpaved roads, and construction of buildings (dairy structures and future residences on the project site). The applicant has indicated that diesel-fueled equipment would be used during grading, including scrapers, water trucks, backhoes, bulldozer, and miscellaneous equipment.

Substantial short-term PM$_{10}$ emissions would cause a temporary increase in localized PM$_{10}$ concentrations. Soils exposed during excavation and grading would be subject to wind erosion. The highest potential for PM$_{10}$ emissions would occur when the soils are dry during late spring, summer, and early fall. PM$_{10}$ emissions are considered by SJVUAPCD to be the pollutant of greatest concern from construction activities.

As previously mentioned, the proposed dairy facilities would be completely located on the project site. Dairy units A, B, C, and D would consist of 960, 1,116, 2,399, and 1,440 acres, respectively. A dairy facility would be constructed on a portion of each dairy unit. Approximately 103 acres of the proposed Dairy A unit would become a dairy facility. Similarly, 103, 225, and 130 acres of the proposed Dairies B, C, and D, respectively, would become dairy facilities. An estimated range between 101,000 and 174,000 cubic yards of soil would be moved on the dairy units during construction; soils would not be imported or exported from the project site.

The total amount of PM$_{10}$ emissions resulting from grading activities could potentially be on the order of 103 pounds per day or 4,706 pounds total, based on an average grading rate of about ten acres per day for a period of two months and a PM$_{10}$ emission factor of 220 pounds per acre-month; the estimate assumes that grading activities would be completed one dairy at a time (Table 4.2-5).\textsuperscript{13}

In addition, four residences may be constructed on the project site, one at each proposed dairy unit. Construction of these homes would also generate PM$_{10}$ emissions from site preparation, soil excavation, grading, equipment traffic, and building construction.

---

\textsuperscript{13} The emission factor is consistent with that used in the URBEMIS7G computer model for estimating PM$_{10}$ emissions from fugitive dust and is based on a report prepared for the South Coast Air Quality Management District (Jones & Stokes Associates, 1998).
The SJVUAPCD has established comprehensive control measures for PM$_{10}$ emissions from construction-related activities. The control measures are divided into the following three components: 1) control measures from the SJVUAPCD Regulation VIII - Fugitive PM$_{10}$ Prohibitions, Rule 8020, 2) enhanced control measures, and 3) additional control measures. Regulation VIII control measures are required for all construction projects and aim to reduce the amount of PM$_{10}$ emissions generated from fugitive dust sources. Enhanced and additional control measures provide a greater degree of PM$_{10}$ reduction compared to Regulation VIII. According to SJVUAPCD, enhanced control measures are applicable to construction projects that would be expected to generate large PM$_{10}$ emissions and additional control measures are applicable for projects with large construction sites, located near receptors, or that for other reasons warrant additional emissions reductions.  

PM$_{10}$ emissions generated from fugitive dust during construction-related activities would constitute a significant impact since the emissions would impair short-term air quality and could expose nearby residents and other receptors, such as the rural residences and mobile homes located less than 2.0 miles northwest, northeast, and east of the project site. In addition, the SJVUAPCD would consider project construction activities to be a significant impact if the established control measures were not implemented.

**Mitigation Measure 4.2-1(a)**

The owner/operator and construction crew shall ensure that the following dust control measures specified in SJVUAPCD Regulation VIII, Rule 8020 are implemented during construction activities, as a condition of approval, to reduce PM$_{10}$ emissions:

- All disturbed areas, including storage piles, that are not being actively used for construction purposes, shall be effectively stabilized to minimize fugitive dust emissions using water, chemical stabilizer/suppressant, or vegetative ground cover.

---

16 Based on the Guide for Assessing and Mitigating Air Quality Impacts established by the San Joaquin Valley Unified Air Pollution Control District; the Guide does not provide a quantitative threshold that would trigger the implementation of enhanced and additional control measures. The need for enhanced and additional control measures would be determined on a case-by-case basis.
• All on-site unpaved roads and off-site unpaved access roads shall be effectively stabilized to minimize fugitive dust emissions using water or chemical stabilizer/suppressant;

• All land clearing, grubbing, scraping, excavating, land leveling, grading, and cut and fill activities shall be controlled to minimize fugitive dust emissions using application of water or by presoaking;

• All operations shall minimize the accumulation of mud or dirt on adjacent public streets or expeditiously remove dirt at least once every 24 hours when operations are occurring (the use of dry rotary brushes is expressly prohibited except where preceded or accompanied by sufficient wetting to limit the visible dust emissions; use of blower devices is expressly forbidden); and

• Following the addition of materials to, or the removal of materials from, the surface of outdoor storage piles, the piles shall be effectively stabilized to minimize fugitive dust emissions using sufficient water or chemical stabilizer/suppressant.

**Mitigation Measure 4.2-1(b)**

The owner/operator and construction crew shall select from the following SJVUAPCD-developed enhanced and additional control measures for implementation during construction activities as a condition of approval to reduce PM$_{10}$ emissions:

• Limit traffic speeds on unpaved roads to 15 miles per hour;

• Install sandbags or other erosion control measures to prevent silt runoff to public roadways from those portions of the site with a slope greater than one percent;

• Wash off all trucks and equipment leaving the site;

• Install temporary wind breaks at windward side(s) of the construction areas;

• Suspend excavation and grading activity when winds exceed 20 miles per hour; and

• Limit the areal extent of land subject to excavation, grading, and other construction activity at any one time.

**Mitigation Measure 4.2-1(c)**

The Kings County Code Compliance Specialist shall inspect construction areas to ensure that construction activities are conducted in accordance with SJVUAPCD control measures identified in (a) and (b) above.
Implementation of the above mitigation measures would reduce construction-related PM$_{10}$ emissions to a less-than-significant level.

Impact 4.2-2

Construction related exhaust emissions. This is a significant impact.

Construction activities would generate short-term exhaust emissions from heavy-duty construction equipment; three scrapers, two water trucks, one bulldozer, and miscellaneous equipment would be used during construction of each dairy. The primary pollutants associated with exhaust emissions from construction-related equipment consist of ozone precursors (ROG and NOx) and PM$_{10}$. Daily exhaust emissions due to grading activities were estimated based on a grading duration of approximately two months, eight hour work days, and emission factors from the URBEMIS7G computer model prepared for SJVUAPCD for selected construction equipment (Table 4.2-6) (Jones & Stokes Associates, 1998); the estimate assumes that grading at one dairy would be completed before grading at the next dairy begins. Approximately 519 pounds of ROG, 7,954 pounds of NOx, and 702 pounds of PM$_{10}$ could be generated from exhaust during grading activities at the project site.

PM$_{10}$ emissions from exhaust emissions (ROG, NOx, and PM$_{10}$) generated during construction-related activities would constitute a significant impact since the emissions would impair short-term air quality and could expose nearby residents and other receptors located downwind (e.g., poultry farm residence located 175 feet from the southern project boundary) to temporary substantial pollutant concentrations.

**Mitigation Measure 4.2-2**

As a condition of approval, the owner/operator and construction crew shall ensure that the following control measures are implemented during construction activities to reduce exhaust emissions from construction related equipment:

---

17 The emission factor is consistent with that used in the URBEMIS7G computer model for estimating PM$_{10}$ emissions from fugitive dust and is based on a report prepared for the South Coast Air Quality management District (Jones & Stokes Associates, 1998).
SECTION 2
SUMMARY

INTRODUCTION

This section provides a summary of the proposed project and areas of controversy that have been identified by the public and public agencies in response to the Notice of Preparation. This section also provides a summary of the discretionary actions required to implement the proposed project.

PROPOSED PROJECT

The proposed project evaluated in this Environmental Impact Report (EIR) consists of the construction and operation of four dairies. The dairies would be located on a 5,915-acre site approximately 5.5 miles south of Hanford and 4.7 miles northwest of Corcoran in an unincorporated area of Kings County. The site is designated "General Agriculture" in the Kings County General Plan and is zoned General Agriculture-40 acre minimum parcel size (AG-40).

The four dairy units would range in size from 960 to 2,399 acres. The dairy facilities, including dairy barns and outdoor corrals, would occupy a small portion of each dairy unit. The dairies would support a total herd size of about 47,700 cattle, of which 24,800 would be producing cows and the remainder related stock, such as dry cows, heifers, and calves. The dairy operations would generate process water and dry manure. The process water would be mixed with well and/or surface water and used to irrigate crops grown on the remainder of the site, which will be used for feed for the cattle. Dry manure would be used as fertilizer at off-site farming operations.

NOTICE OF PREPARATION AND SCOPING SESSIONS

A Notice of Preparation (NOP) was prepared and distributed to public agencies, community organizations, and all adjacent property owners. The NOP contained a detailed project description and an Initial Study (environmental checklist) that indicated which environmental issues were proposed to be studied in depth in the environmental impact report. The NOP solicited public response as to the issues that should be included in the EIR. The NOP was mailed out on 17 July 1999 and responses were requested within a 30-day period, as required by Section 15082(a) of the CEQA Guidelines.
Land uses in the area adjacent to the project site are dominated by intensive agriculture, but also include non-irrigated fields, three poultry farms, rural farm residences, and evaporation ponds operated by the Tulare Lake Drainage District. There are nine residences within 1.0 mile of the proposed dairies, including at least one mobile home that is not occupied. There are no existing residences on the four proposed dairy units.

PROJECT CHARACTERISTICS

The Chamberlain Ranch Planned Dairy Development consists of the construction and operation of four dairies (Figure 3-2). The applicant, J.G. Boswell Company, has applied to receive permits for four separate dairy operations. The company would not construct or own the dairies; the permitted dairy sites would be sold to dairy operators.

The applicant has submitted four conditional use permit applications to Kings County for Dairy units A, B, C, and D, including technical reports and plans that identify the location of each of the dairy facilities, as well as the surrounding agricultural fields to be used for feed production and irrigation with process water.

Project Data

The acreage of the four dairy units varies in size from 960 to 2,399 acres (Table 3-1). The proposed area of the dairy facilities ranges from 103 to 225 acres. Each dairy would consist of freestall corrals, dairy barns, pasture, roads, settling ponds and lagoons (Figure 3-3), and associated facilities, surrounded by crop lands. The surrounding agricultural fields would produce feed crops, such as silage for the dairy herd, and would be irrigated with well and surface water mixed, at times, with process water generated at the dairy facilities.

The number of animals each site is proposed to accommodate ranges from 7,560 head (milking cows and support stock) at Dairy A to 19,900 head (milking cows and support stock) at Dairy C. The total number of dairy stock for the proposed four dairies would be approximately 47,700 animals, including 24,804 lactating cows (Table 3-1).

<table>
<thead>
<tr>
<th>TABLE 3-1: Project Data for Chamberlain Ranch Dairies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop land (acres)</td>
</tr>
<tr>
<td>Dairy facility (acres)</td>
</tr>
<tr>
<td>Total site (acres)</td>
</tr>
<tr>
<td>Milk cows</td>
</tr>
<tr>
<td>Total herd</td>
</tr>
<tr>
<td>Total animal units</td>
</tr>
</tbody>
</table>

Source: Nevins, 1998a, b, c, d and BASELINE.
Ozone is one of the most ubiquitous pollutants which causes damage to vegetation. Forest ozone damage has been reported in California (Miller et al. 1996), New England (Treshow 1984), the southeastern US (Skelly et al. 1997), and Europe (Rennenberg et al. 1997). Ozone is formed from nitrogen oxides and volatile organic hydrocarbons (VOCs) in the presence of sunlight in source areas—cities, major transportation corridors, industrial sites and agricultural areas—and is transported via air masses to downwind forests where it is deposited. Ozone is a potent oxidant which invades tree foliage through stomatal pores and damages cell constituents responsible for normal physiological function (Heath and Taylor 1997).

Sierra Nevada forests receive ozone in plumes which originate from precursors in the urban centers, transit corridors, industrial and agricultural areas of the Central Valley and coast (Cahill et al. 1996). Air mass trajectories carry polluted air SSW through the Central Valley until deflected into the Sierra Nevada Mts. near Sequoia National Park by the transverse Tehachapi Range. Air masses with pollution from the Los Angeles area move eastward directly into the San Bernardino Mts. While ozone pollution in the urban areas of California has declined in general over the last 20 years, ozone pollution in remote natural areas has increased. In 1999 the National Park Service ranked Sequoia/Kings Canyon National Park (SEKI) the "worst ozone polluted park" of any National Park in the country.

Ponderosa pine is very sensitive to ozone pollution and has been studied extensively in relation to ozone damage. Ponderosa pine is the most abundant western conifer and is an important forest species in California, both economically and ecologically. Ozone impact on ponderosa and Jeffrey pine in the Sierra Nevada and San Bernardino Mts. has been monitored since the 1970's. The following symptoms have been observed and attributed to ozone exposure: visible chlorotic mottling; needle loss; loss of basal area; species replacement by forest species more tolerant of ozone, but less tolerant of fire; changes in forest physiology; changes in nutrient use (Pronos et al. 1978, Pronos and Vogler 1981, Miller 1973, Stolte and Bennet 1985, Miller and McBride 1988, Miller 1996).

Ozone injury has been well-documented in the San Bernardino Mts. downwind of Los Angeles (Miller et al. 1996, Grulke et al. 1998, Grulke 1998, Grulke and Balduman 1999, Miller 1973, Stolte and Bennet 1985, Miller and McBride 1998, Miller 1996). At the 2 sites nearest L.A., 100% of measured trees had ozone injury. At the site most distant from L.A. 96% of trees measured had ozone injury. Forests of the Sierra Nevada Mts. in California are impacted by ozone as well (Miller and McBride 1988, Cahill et al. 1996, Miller 1996). Ozone injury was measured annually on 1700 ponderosa and Jeffrey pine at 11 different sites in the Sierra Nevada Mts. from 1990-1995. Ozone damage was observed at all sites measured. At the most damaged site, Sequoia National Park, 93% of ponderosa pine had ozone injury. The least damaged site, in Yosemite National Park, reported 39% ponderosa pine with ozone injury (Arbaugh et al. 1998).

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001564
APPENDIX M
Monitoring and Evaluation of Water Quality Under Central Valley Dairy Sites
Harley H. Davis
Central Valley Regional Water Quality Control Board
Sacramento, CA

1995 California Plant and Soil Conference
Visalia, CA 11 January 1995

Introduction

The Central Valley Regional Water Quality Control Board received funding from the Federal Statewide Basin Planning Program to evaluate the impact of dairy waste management practices on ground water quality. In June 1993, a drilling company installed forty-four shallow monitoring wells at five cooperating dairies using these funds. Dairies were selected to determine what usually occurs under typical well run dairies. Regional Board staff located monitoring wells in or near the corrals, waste water ponds and fields at the cooperating dairies. The dairies are in Merced and Stanislaus Counties near the cities of Modesto and Turlock. Figure 1.0 shows the location of these cooperating dairies. Dairies C-1 and C-2 are in Merced County. Dairies D, F and G are in Stanislaus County.
Profile of Cooperating Dairies

The sizes of the dairies in the study vary between 400 and 900 milk cows. Average dairy size for Stanislaus and Merced Counties is about 350 milk cows. The dairies in the study have been in operation for at least fifteen years. Two of the dairies began in the 1910's but have been modernized and expanded extensively.

Dairy operations are typical of dairies in the two counties. They include the use of corrals, dairy waste water retention ponds and irrigated crop land. Crop land receives dairy waste water. Manure is either flushed from feed or free stall alleys into waste water ponds or scraped from corrals and piled for various uses. At three of the dairies, solids are separated from liquid wastes before the liquid enters the ponds.

Crop land management is also typical of dairies in the region. Oats, barley, wheat, corn and alfalfa are grown for feed in 18 fields on 528 acres surrounding the five dairies. In addition, one dairy grows wine grapes in three fields covering 180 acres.

Nearly all the fields received dairy lagoon waste water in 1993. Only three of the twenty-one fields received dry manure solids in 1993. Besides nitrogen in the waste water, every dairy except Dairy F in Stanislaus County added nitrogen in commercial fertilizer to its crop land. The two other dairies in Stanislaus County applied 100 to 112 pounds of commercial nitrogen fertilizer per acre in 1993. The two dairies in Merced County applied from 204 to 306 pounds of commercial nitrogen fertilizer per acre in 1993. Rough calculations of crop nitrogen needs showed that there might be potential to reduce fertilizer applications to some fields. In 1994, the two Merced County dairies and one in Stanislaus County will be using less commercial nitrogen fertilizer. The field managers for these dairies will determine the effect of reducing commercial fertilizer on crop growth and yield.

Soils at the cooperating dairies have sandy and course materials throughout the profile. These soils provide conditions that are generally conducive to the movement of soluble chemicals. Nitrates from the soil profile can migrate into the shallow ground water aquifer under such highly permeable soils. The sandiest soils with the greatest permeability are found at the two Merced County dairies. The Stanislaus County dairies in the study area have higher contents of clays and silt. These soils are less permeable than the soils of the two Merced County dairies. However, the soils at the Stanislaus County dairies are still highly permeable to the movement of soluble chemicals such as nitrates.

Summary of Preliminary Monitoring Results

Monitoring wells were sampled five times: (1) in June 1993 after drilling was completed, (2) in September-October 1993 after the summer crop growing season, (3) in March 1994 after winter rains, (4) in June 1994 which completed one year of sampling and (5) in July-August 1994 to determine changes in concentrations during the growing season. The water table is shallow, ranging in depth from 4 to 25 feet below the surface. The monitoring wells were constructed to collect water representative of the top 10 feet of the shallow aquifer.
Average concentrations of nitrate in monitoring wells varied among the fields, ponds and corrals. Figure 2.0 displays these concentrations for samples collected from June 1993 through August 1994. The fields showed the lowest concentrations averaging 38 mg/l of nitrate nitrogen. The monitoring wells in corrals averaged 74 mg/l of nitrate nitrogen. Nitrate nitrogen near the waste water ponds averaged 45 mg/l of nitrate nitrogen. The average of all monitoring wells in the study was 49 mg/l. All averages were above the drinking water standard of 10 mg/l.

Most drinking water wells in the vicinity of the dairies draw from aquifers greater than 100 feet deep but at least one known nearby domestic well draws from the shallow aquifer of the monitoring wells. Local public health officials during review of new well applications normally limit the use of surface and shallow aquifers for drinking water. They require well seals that prevent surface contamination and well screening below shallow ground water.

Use of waters from the monitoring well aquifer would be limited to more salt tolerant crops. The nitrates from this aquifer would be of benefit to the nitrogen supply of agricultural crops. However, the salt content would most likely need to be diluted to prevent crop damage and loss of production. Nitrates from the shallow ground water of the monitoring wells could be removed by using this water on crops. Use of shallow ground water for irrigation would provide a savings in fertilizer and well water pumping expenses. Pumping costs from shallow ground water would be less costly than the expense of pumping from deeper wells that are commonly used for irrigation.
Total dissolved solids (TDS) and electrical conductivity (EC) are measurements of the salinity of water. TDS concentrations ranged from 270 to 4100 mg/l. EC varied from 449 to 6120 μs/cm. For all monitoring wells, the mean TDS was 1217 mg/l and EC was 1911 μs/cm. The ratio of TDS to EC averaged 0.65 but ranged from 0.37 to 0.99.

Acceptable water quality concentrations for salts vary with the intended use. Livestock, irrigated agriculture and drinking water are the primary uses of ground water in the vicinity of the dairies. According to the USGS in the Study and Interpretation of Chemical Characteristics of Natural Waters (1989), some investigators recommended an upper limit of nearly 5,000 mg/l of dissolved solids in water to be used by livestock.

Agricultural water quality goals are 450 mg/l for TDS and 700 μs/cm of EC as recommended by the Food and Agriculture Organization of the United Nations (1989). However, different crops are sensitive to varying levels of salinity. Most fruit and nut crops are sensitive to EC levels from 700 to 1,200 μs/cm. Concentrations above these levels result in reductions in crop yields. But many grasses and some grain crops, such as barley and oats, are more tolerant to higher salt levels in irrigation water. These crops tolerate EC values from 4,000 to 6,500 μs/cm without loss in crop yields.

Primary drinking water standards have not been recommended for TDS. However, the 1962 U.S. Public Health Service secondary drinking water standard states that TDS should not exceed 500 mg/l if other suitable water supplies are available.

Salinity concentrations varied among the monitoring wells in the fields, ponds and corrals. Figure 2.0 displays averages for samples collected from June 1993 through August 1994. The monitoring wells in the fields showed the lowest concentrations averaging 925 mg/l of TDS. The monitoring wells in corrals averaged 1689 mg/l of TDS. TDS concentrations in monitoring wells near the waste water ponds averaged 1294 mg/l. Average for all monitoring wells in the study was 1217 mg/l of TDS.

Table 1.0 displays nitrogen concentrations in the monitoring wells. Nitrate as nitrogen ranged from less than the detectable limit of 0.02 mg/l near an irrigation water pond to 250 mg/l under a corral. The average nitrate as nitrogen for the monitoring wells in the dairy study was 49 mg/l. The national drinking water standard for nitrate as nitrogen is 10 mg/l which is equivalent to 45 mg/l of nitrate. High concentrations of nitrates in drinking water have caused methemoglobinemia which is commonly known as blue baby syndrome. Nitrates in irrigation water provide nitrogen as a nutrient to crops.

Monitoring wells away from the corrals and ponds in four of the five dairies had nitrate nitrogen concentrations below 10 mg/l. These low concentrations indicate that the regional shallow aquifer contains low nitrate levels. Lowest concentrations of nitrates generally ranged from 3 to 14 mg/l. These lowest concentrations were at well locations that were minimally affected by the dairy operations. Concentrations in what were expected to be the background wells showed that these particular wells were most likely influenced by dairy operations or other nitrogen sources.
Monitoring wells were located to determine the probable sources of contamination from waste water ponds, corrals or fields. Background monitoring wells were also located upgradient of the dairy operations. Table 1.0 gives a summary of monitoring well water quality for nutrients and salts. EPA and other standard laboratory methods were used. Nitrates \((\text{NO}_3^-)\) and total dissolved solids are of particular interest to ground water quality.

### Table 1.0 Summary of Monitoring Well Water Quality

<table>
<thead>
<tr>
<th>DAIRY NAME</th>
<th>PO(_4)-P</th>
<th>NH(_3)-N</th>
<th>TK-N</th>
<th>NO(_2)-N</th>
<th>NO(_3)-N</th>
<th>TOTAL N</th>
<th>TDS</th>
<th>EC</th>
<th>µS/cm</th>
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<tr>
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<td>30</td>
<td>24</td>
<td>24</td>
<td>30</td>
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<td>86</td>
<td>90</td>
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<td>1.1</td>
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<td>6.8</td>
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<td>130</td>
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<tr>
<td>Minimum</td>
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<td>0.1</td>
<td>&lt;0.5</td>
<td>&lt;0.02</td>
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<td>3</td>
<td>270</td>
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### Summary of Dairies

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<th>NUMBER OF SAMPLES</th>
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<th>TK-N</th>
<th>NO(_2)-N</th>
<th>NO(_3)-N</th>
<th>TOTAL N</th>
<th>TDS</th>
<th>EC</th>
<th>µS/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Dairies</td>
<td>45</td>
<td>75</td>
<td>174</td>
<td>50</td>
<td>216</td>
<td>176</td>
<td>176</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>Average (Mean)</td>
<td>1.2</td>
<td>4.4</td>
<td>2.5</td>
<td>0.13</td>
<td>49</td>
<td>52</td>
<td>1217</td>
<td>1860</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>5.2</td>
<td>93</td>
<td>57</td>
<td>1.2</td>
<td>250</td>
<td>251</td>
<td>4100</td>
<td>6120</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.16</td>
<td>&lt;0.05</td>
<td>&lt;0.5</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>3</td>
<td>270</td>
<td>449</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.98</td>
<td>14.4</td>
<td>8.1</td>
<td>5.59</td>
<td>43</td>
<td>43</td>
<td>612</td>
<td>931</td>
<td></td>
</tr>
</tbody>
</table>

Note: Summary of dairy data is from all wells and not the rows above.
Figure 3-10: Concentration by Source of Nitrate Nitrogen in Monitoring Wells

PROBABLE SOURCE

\[\text{NO}_3^-\text{N (mg/L)}\]

Standard  Fields  Ponds  Corrals  All
the districts to conduct an annual inspection of each dairy facility. The requirements/regulations of the mosquito abatement districts have already been incorporated into standard conditions of approval or are addressed in Mitigation Measures #4.3.6-1 and #4.3.6-2. Inspections are considered routine for mosquito abatement districts.

Response to Comment 22: Refer to Comment 21 above. As stated in the Implementation/Monitoring discussion for Mitigation Measure #4.3.6-2, the measure would be incorporated into the conditions of approval for individual facilities. Monitoring of conditions of approval is the responsibility of the RMA; nuisance and/or abatement is handled by the responsible abatement district.

A review of violations received by RMA for the past 2 years revealed that no complaints regarding mosquito problems have been received. The basis for all complaints received dealt with the expansion of facilities without a use permit or non-compliance with conditions of approval regarding district standards. In the latter case, this typically related to the lack of access for abatement/maintenance, or construction of wastewater lagoons which did not meet district standards. All violations involving compliance with conditions of approval have been resolved.

Response to Comment 23: Refer to Response to Comment 6 above.

Response to Comment 24: Refer to Response to Comments 14, 15, 16, 17, 18 and 19 above.

Response to Comment 25: Refer to Response to Comment 6. Baseline information on the state of water quality in those portions of the county where animal confinement projects under the plan are likely is not available. Regular groundwater monitoring is currently only required for public water systems. Some of the cities in the county (e.g., Visalia, Tulare) have conducted studies to evaluate groundwater in the immediate area of their sewage treatment plants. In the case of the Visalia study, groundwater testing did reveal high concentrations of nitrate below some, but not all of the older dairies in the area (mainly below the corrals and/or sumps). The extent of the contamination was localized and would not provide an adequate overview of the status of the groundwater in the county. With the adoption of the ACFP, information will be collected to provide an appropriate baseline and to provide early detection of potential contamination before its spreads to potable groundwater.

A review of RMA's code enforcement records indicated that violations of RWQCD requirements typically involved standing water. Based on information from the CVRWQCD, only two or three monitoring wells have been required in Tulare County when determined necessary based on individual Reports of Waste Discharge.

Response to Comment 26: The mentor's recommendation regarding the alternatives is noted for the record.
Lagoon Seepage and Mass Loading of Pollutants
Calculations for the Borba Dairy, Kern County, California
Prepared for the Protestants of the Borba Dairy
July 20, 2000

The following calculations were performed by Kathy J. Martin, PE of Martin Environmental Services, Norman, Oklahoma at the request of counsel for the Protestants of the Borba Dairy. Ms. Martin has a Master's Degree in Civil Engineering from the University of Oklahoma (1989) and is a licensed professional engineer in Oklahoma for Civil Engineering. Her resume is attached and includes work experience in the field of environmental permitting for industrial wastewater. She drafted the rules and regulations used by the State of Oklahoma since 1990 to regulate surface impoundments and land application as they relate to facilities that generate non-hazardous industrial wastewater. In addition, Ms. Martin has been working on CAFO related issues full-time since 1997 including CAFO permitting processes in Oklahoma, Kansas, Nebraska, Utah, Missouri, Arkansas, Iowa, and Wyoming. She has performed technical and regulatory reviews of permit applications for over 45 different CAFO facilities, including large-scale swine operations, liquid manure dairy systems, and related wastewater treatment systems used by poultry slaughtering facilities in West Virginia (ie., surface impoundments and land application). She is familiar with the federal and state regulations governing CAFOs, as well as the Clean Water Act and Water Quality Standards.

Volume of Seepage from Lagoons:
According to the application, there are 19.5 acres of lagoons per dairy "site". The lagoons are designed to have a seepage rate of 1 x 10^-5 cm/sec, which is equivalent to 9236 gal/acre/day seepage:

\[ 1 \times 10^{-5} \text{ cm/sec (in/2.54 cm)}(\text{gal/231 in}^3)(3600 \text{ sec/hr})(24 \text{ hr/day})(144 \text{ in}^2/\text{ft}^2)(43580 \text{ ft}^2/\text{acre}) \]

The seepage rate is reported in volume per unit area, which is a rate of flow of wastewater through the saturated liner of the lagoon. According to the September 3, 1999 report to Kern County, Borba intends to construct the lagoons according to NRCS guidelines and will attempt to achieve this seepage rate. There are two types of seepage in lagoons - vertical seepage along the bottom of the lagoon and a combination of vertical and horizontal seepage at the berms. One method to estimate seepage from a lagoon given minimal design information is to use the surface area at maximum liquid depth as an estimation of both vertical and horizontal seepage. Considering that horizontal seepage is much higher than vertical seepage when using a properly compacted clay liner, this broad method of estimation is conservative in that it can overestimate seepage due to only vertical paths on the bottom of the lagoon (ie., a smaller surface area of flow). However, when attempting to protect groundwater, it is prudent to overestimate seepage rather than underestimate seepage. The seepage calculation does not include losses due to failure of the lagoon, which will be termed leakage in this report.
This seepage can be compared to the surface area of the lagoons at each site:
9236 gal/acre/day \times 19.5 \text{ acres} \times 365 \text{ d/yr} = 65.7 \text{ million gallons per year per facility}
65.7 \text{ million gallons per year \times 2 facilities} = 131.47 \text{ million gallons per year}

**Mass Loading in Seepage**
The mass loading of pollutants in the seepage can be calculated using average concentrations of salts as found in lagoon wastewater reported in "Seepage Rates and Ground Water Quality Impacts from Manure-Lined Dairy Waste Lagoons" published by the Environmental Improvement Division, Ground Water and Hazardous Waste Branch of the New Mexico Health and Environment Department (late 1980's).

Average values for total dissolved solids, bicarbonates, chlorides, sodium, ammonia, and total nitrogen were calculated using the following values from the report:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TDS (ppm)</th>
<th>Bicarb (ppm)</th>
<th>Ammonia (ppm)</th>
<th>TKN (ppm)</th>
<th>Chlorides (ppm)</th>
<th>Sodium (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300</td>
<td>663</td>
<td>22.2</td>
<td>75.3</td>
<td>123.6</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>1285</td>
<td>1051.5</td>
<td>83.4</td>
<td>131</td>
<td>153.9</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>5052</td>
<td>1978</td>
<td>73.7</td>
<td>87.2</td>
<td>910</td>
<td>449</td>
<td></td>
</tr>
<tr>
<td>2869</td>
<td>1649</td>
<td>27.2</td>
<td>194</td>
<td>448</td>
<td>191</td>
<td></td>
</tr>
<tr>
<td>2630</td>
<td>1565</td>
<td>219</td>
<td>257</td>
<td>706</td>
<td>435</td>
<td></td>
</tr>
<tr>
<td>2280</td>
<td>1391</td>
<td>164</td>
<td>285</td>
<td>773</td>
<td>476</td>
<td></td>
</tr>
<tr>
<td>3412</td>
<td>85</td>
<td>185</td>
<td>81</td>
<td>152</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>63.9</td>
<td>118</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>174.8</td>
<td>128.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>average</td>
<td>2691</td>
<td>1383</td>
<td>101</td>
<td>164</td>
<td>518</td>
<td>308</td>
</tr>
</tbody>
</table>

Mass loading is calculated using the annual volume of seepage (million gallons/year) multiplied by the concentration (ppm) and a conversion factor (8.34 lbs/million gallons):

Total Dissolved Solids calculated at 681 tons per year per facility:
60.68 mil gal/yr \times 2691 ppm \times 8.34 lbs/mil gal = 1,361,837.5 lbs TDS/yr

Bicarbonate salts calculated at 350 tons per year per facility:
60.68 mil gal/yr \times 1383 ppm \times 8.34 lbs/mil gal = 899,896 lbs Bicarb/yr
Chloride salts calculated at 131 tons per year per facility:
60.68 mil gal/yr x 519 ppm x 8.34 lbs/mil gal = 262,650 lbs Na/yr

Sodium salts calculated at 78 tons per year per facility:
60.68 mil gal/yr x 308 ppm x 8.34 lbs/mil gal = 155,869 lbs Cl/yr

Total nitrogen compounds at 41 tons per year per facility:
60.68 mil gal/yr x 164 ppm x 8.34 lbs/mil gal = 82,995 lbs TKN/yr

Summary of mass loading is provided in the following table:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lbs/yr</th>
<th>tons/yr</th>
<th>lbs/design</th>
<th>tons/design</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>1,361,837.5</td>
<td>681</td>
<td>27,236,750</td>
<td>13,618</td>
</tr>
<tr>
<td>Bicarb</td>
<td>699,896</td>
<td>350</td>
<td>13,997,920</td>
<td>6,999</td>
</tr>
<tr>
<td>Chlorides</td>
<td>262,650</td>
<td>131</td>
<td>5,253,000</td>
<td>2,626</td>
</tr>
<tr>
<td>Sodium</td>
<td>155,869</td>
<td>78</td>
<td>3,117,380</td>
<td>1,559</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>62,995</td>
<td>41</td>
<td>1,659,912</td>
<td>830</td>
</tr>
</tbody>
</table>

Combined Mass Loading – Both Dairy Facilities
Design Life of 20 years

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lbs/yr</th>
<th>tons/yr</th>
<th>lbs/design</th>
<th>tons/design</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>2,723,675</td>
<td>1,362</td>
<td>54,473,500</td>
<td>27,237</td>
</tr>
<tr>
<td>Bicarb</td>
<td>1,399,792</td>
<td>700</td>
<td>27,995,840</td>
<td>13,998</td>
</tr>
<tr>
<td>Chlorides</td>
<td>625,300</td>
<td>263</td>
<td>10,506,000</td>
<td>5,253</td>
</tr>
<tr>
<td>Sodium</td>
<td>311,738</td>
<td>156</td>
<td>6,234,760</td>
<td>3,117</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>165,990</td>
<td>83</td>
<td>3,313,800</td>
<td>1,660</td>
</tr>
</tbody>
</table>

These estimates of seepage do not include the seepage losses from the barns nor from the solids separation: trenches located hydraulically prior to the waste lagoons. Therefore, the total seepage from this facility would be more than that indicated in the tables. It is important to note that whatever losses that do not occur from the lagoon(s) represent a volume of wastewater that must still be disposed of by land application. The mass loading of pollutants on the aquifer includes not only the mass loading in the allowable seepage from each lagoon at each facility, but also the mass loading due to disposal by land application for both facilities. That additional mass loading was not calculated in this
report, but it is highly recommended that more study be made to determine the total loading on the aquifer system for nitrogen compounds and especially for total dissolved solids (salts).

Environmental Concerns
The Agency must evaluate the mass loading of these salts on the unconfined groundwater aquifer that is located beneath the facilities. This groundwater is already known to be contained with little or no egress, which causes salts to accumulate in the groundwater basin. The allowable seepage is extremely high as compared to that allowed for municipal lagoons (typically 500 gallons per acre per day). The seepage for the very concentrated dairy wastewater is more than 18 times that allowed for the more dilute domestic sanitary wastewater.

The EIR indicates more shallow groundwater systems than those admitted to at depths of 130 feet. The report includes reference to a sand layer underlain by a thick clay layer at the facility. This sand/clay interface apparently occurs at depths of 40 feet. A sand layer underlain by clay, albeit intermittent clay in this region, is considered by most hydrogeologists to be a "perched" aquifer. The perched aquifer may not accumulate enough water to be a "producing" aquifer, but it can be considered waters of the state and protected as such. The perched water can and will interact with underlying aquifers at the point of saturation of the intervening clay layer, or sooner with the horizontal movement of the perched water to the edge of the clay layer. This phenomena allows wastewater to travel laterally beyond the expected boundary of the lagoon. In other words, the wastewater will not just seep straight down to the aquifer, but may travel in a lateral direction dictated by the slope of the intervening clay layer and enter the underlying aquifer materials at some point different than that of the lagoon. Monitoring wells should be set up to detect this movement.

The use of existing water wells as the groundwater monitoring for this facility is a lax enforcement of groundwater quality standards. The wells built to produce large quantities of groundwater are not necessarily built to detect pollution. The non-nitrogen salt pollution will occur at different depths than the more mobile ammonia and nitrate pollution. The nitrogen pollution is proposed to be detected by "nitrates" instead of ammonia and nitrates. It is well known that ammonia and nitrate levels in the groundwater will be inversely proportional as the microbial community transforms dissolved ammonia into nitrite and nitrate. Therefore, the lack of detection of nitrates is not a proof-positive indicator of no pollution. The testing must include more conservative pollution parameters, such as chlorides, bicarbonates, and sodium in addition to ammonia, nitrates, and total nitrogen.

This report was prepared by Kathy J. Martin, PE in Norman, Oklahoma
Signature: Kathy Martin
Date: July 21, 2000
Seal: Oklahoma PE #18254

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Seepage Calculations and Mass Loading of Dairy Facilities
Prepared by Kathy J. Martin, PE, Martin Engineering Services, Inc., Norman, Oklahoma
July 20, 2000

001578
KATHY J. MARTIN, PE
122 Tall Oaks Circle • Norman, Oklahoma 73072 • Telephone: (405) 321-3176

CURRENT POSITION

ENVIRONMENTAL CONSULTANT, MARTIN ENVIRONMENTAL SERVICES, NORMAN, OK
Professional engineer in Civil Engineering providing expertise in areas of industrial
permitting for air quality, non-hazardous industrial wastewater, and closure of surface
impoundments. Perform engineering review and critique of permit applications
submitted by swine facilities to regulatory agency with respect to wastewater treatment
technology and compliance with environmental regulations.

EDUCATION

UNIVERSITY OF OKLAHOMA
M.S. Civil Engineering, 1989
Thesis: The Removal of Polychlorinated Biphenyls from Topsoil Using Nonionic
Surfactants

UNIVERSITY OF OKLAHOMA
B.S. Petroleum Engineering, 1987
National Dean's List, 1986-87

EXPERIENCE

SEWARD COUNTY COMMISSIONERS, SEWARD COUNTY, KANSAS
Subcontracted as Martin Environmental Services, June - October 1998
Drafted environmental regulations for confined animal feeding operations including
design, construction, operation, maintenance, and closure of surface impoundments
and land application of CAFO wastewater. Draft regulations include a "stand-alone"
permitting program with public notice, hearings, permitting processes, fees, compliance
and enforcement language.

ADJACENT LANDOWNERS TO SWINE FACILITIES
Subcontracted as Martin Environmental Services, June 1997 to present
Perform technical and regulatory review of approximately 30 license and permit
applications submitted by swine facilities to regulatory agencies in order to determine
if the application is sufficient for a permit writer to draft a permit. The purpose was
to determine if there were technical and/or regulatory deficiencies in the application
and prepare a "protest" of the application for the adjacent landowners.

DEPARTMENT OF ENVIRONMENTAL QUALITY
Environmental Engineer II, July 1, 1993 to November 1, 1996
Special training in areas of Air Quality and Hazardous Waste permits and regulatory
requirements. Provide technical and regulatory assistance to business and industry
with respect to environmental permits issued by the DEQ.

OKLAHOMA WATER RESOURCES BOARD
Environmental Engineer I, April 1990 to June 30, 1993
Special training in areas of industrial wastewater disposal permits and inspections.
Draft state regulations for surface impoundments and land application of non-
common hazardous industrial wastewater. Project officer of Tar Creek Superfund Site.
SKILLS

- Knowledge of CAFO and other environmental regulations
- Extensive research on waste/liner compatibility
- Drafted state regulations for impoundments and landfill application for non-hazardous industrial wastewater
- Drafted county regulations for CAFO impoundments and land application of manure wastewater
- Familiarity with CAFO regulations in OK, KS, NE, MO, AR, and UT
- Professional Engineer in Oklahoma February 1997 to present
- Coordinated Superfund activities between USGS, state and EPA
- Interact with State Legislators (OK and KS) on technical issues (CAFOs)
- Provide expert testimony regarding CAFO licenses/permits in Oklahoma, Kansas, Utah, Nebraska, Missouri, and Arkansas
- Provide technical reviews of CAFOs and other wastewater systems also in Iowa, West Virginia and Michigan
- Three years Chinese language
- Ten years leadership positions in local, state, and national organizations
- Developed state-wide foundry and metal casting facility environmental program – then taught Louisiana and Arkansas to do the same.
- Active contributor to proposed regulatory language with respect to CAFOs at local, state, and federal levels for past three years.
- Provided lectures on CAFO environmental issues to groups in Oklahoma, Kansas, Nebraska and Utah to groups as large as 600 people at a time.

ORGANIZATIONS

- Oklahoma Corporation Commission - Citizen Advisory Board member
- Oklahoma Society of Environmental Professionals - Past President, Past Newsletter Editor, Past Secretary, Past Engineering Board Member
- Society of Petroleum Engineers - Past Executive Committee member as newsletter editor, two years, member 10 years
- National Association of Professional/Graduate Students - Past Board member and National Conference Chairperson
- Graduate Student Senate, University of Oklahoma - Past Chair two years, Past Vice Chair, Past Senator for Civil Engineering Department
- Oklahoma Chapter of Sierra Club - member, 1 year
- Engineering Club of Oklahoma City - past member, 6 years
- OU Petroleum Engineers Club - past Vice President, member 4 years
- OU Society of Women Engineers - past President, member 7 years
- OU Engineer's Club - past Loyal Knight of St. Pat, member 7 years
APPENDIX

P
United States Department of the Interior  
FISH AND WILDLIFE SERVICE  
Sacramento Fish and Wildlife Office  
2800 Cottage Way, W-2605  
Sacramento, California 95825

October 1, 1999

Kris Cardoza  
Associate Planner  
Kern County Planning Department  
Public Services Building  
2700 M Street  
Bakersfield, California 93301-2370

Subject: Proposed Negative Declaration for EA KC 1-99; Conditional Use Permit No. 48, Map No. 142; Conditional Use Permit No. 6, Map No. 160 (Hershel Moore by Brokers of Bakersfield (FPN99230)), Kern County, California

Dear Ms. Cardoza:

This is in response to your September 6, 1999, proposed Negative Declaration for the proposed Hershel Moore Dairy, located on the southeast corner of Bear Mountain Boulevard and Old River Road south of Bakersfield in Kern County, California. The project is to encompass 1,072 acres and is outside the boundaries of the Metropolitan Bakersfield Habitat Conservation Plan. The proposed project will consist of 905 acres of cultivated crops, and 163 acres of dairy facilities, as described in the CUP site plan. Facilities include a milk house, two milk parlors, two drip pens, two sprinkler pens, a maternity hospital barn, a heifer corral, freestall barns, a commodity barn, hay barns, separation ponds for waste, a lagoon for waste, a parking lot, a scale, an office, and two single-family residences. The facility will house 5,000 milk cows and 4,000 support stock.

We are concerned about the effects of the project on San Joaquin kit fox (Vulpes macrotis mutus), which is protected under the Federal Endangered Species Act of 1973, as amended (Act). Kit fox are known to forage in row crops and alfalfa fields and use agricultural fields as travel corridors. We do not agree with the County's determination in the Environmental Checklist Form attached to the Proposed Negative Declaration that this project will have "less than significant impact" on habitat for endangered species. The Service has determined that a mitigation measure is required in order for the project to have a less than significant effect.

Section 9 of the Act and its implementing regulations prohibit the "take" of federally listed fish and wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any listed wildlife species. "Harm" in this definition includes
Ms. Kris Cardoza

significant habitat modification or degradation where it actually kills or injures wildlife, by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3). The Service considers the development of dairy structures on the former cropland to constitute harm to the kit fox, as this area can no longer be used for foraging or travel, and is removed for the foreseeable future from potential denning activities by foxes. While cropland is not as intensely used by kit fox for foraging and travel, it is used, and is becoming more important as foraging habitat and travel corridors as natural lands are converted to other uses. Therefore the Service considers the proposed 163 acres of development on the existing cropland to require incidental take authorization from us under the Act.

Take incidental to an otherwise lawful activity may be authorized for listed species. The Service may issue a permit under section 10 of the Act if Hershel Moore Dairy submits a satisfactory conservation plan for the kit fox and any other species that would be affected by their project. We strongly recommend that the Hershel Moore Dairy work with us to develop a plan that avoids or minimizes take of listed species and compensates for the projects' impacts to listed species habitat. This requirement is consistent with the endangered species protection requirements for dairies under the Metropolitan Bakersfield Habitat Conservation Plan.

The Service requests that the County add a mitigation measure to the Negative Declaration that states that prior to issuance of building or grading permits, the applicant shall submit a copy of an approved permit from the U.S. Fish and Wildlife Service allowing incidental take of endangered species.

Thank you for your interest in conserving threatened and endangered species. Please contact Susan Jones or Peter Cross at (916) 414-6600 if you have any questions about this letter.

Sincerely,

Karen J. Miller
Chief, Endangered Species Division

cc: CDFG, Fresno, California
APPENDIX

Q
ENVIRONMENTAL AND HEALTH CONSEQUENCES OF ANIMAL FACTORIES

Factory farms, which mass-produce animals in assembly-line fashion, have harmed aquatic life, human health and ecosystems across the nation. As industrial-sized farms stagger under the vast burden of manure they are generating, environmental disasters are inevitable. The scale of this unprecedented outpouring of animal waste is staggering: 130 times the waste generated by humans in this country each year.1

This section details how animal waste is poisoning our water and air. It also explains why more disasters are likely to occur unless the nation takes serious steps not only to regulate the way animal factories currently handle their waste but also to turn towards more benign methods of raising animals and managing the wastes they generate.

Water Pollution

Bursting and overflowing manure lagoons have spawned environmental disasters around the country, sending animal waste gushing into rivers, groundwater and coastal wetlands. In 1995, an 8-acre hog waste lagoon in North Carolina burst, spilling 25 million gallons of animal waste into the New River. The spill killed as many as 10 million fish and closed 364,000 acres of coastal wetlands to shellfishing.2 In 1998, a 100,000-gallon spill into Minnesota's Beaver Creek killed close to 700,000 fish.3 In 1997, animal feedlots were responsible for 2,391 spills of manure in Indiana.4 Sixty-three percent of Missouri's factory farms suffered spills between 1990 and 1994, according to Missouri's Department of Natural Resources.5 In 1996, forty spills killed close to 700,000 fish in Iowa, Minnesota and Missouri.6

A North Carolina study of nearly 1,600 wells adjacent to hog and poultry operations showed that 10 percent of the wells tested were contaminated with nitrates above the drinking water standard, and 34 percent were contaminated with some level of nitrates.7 Another study in that state found severe seepage losses of nitrogen from more than 50 percent of the lagoons tested by the state, posing a risk to groundwater.8 While seepage can be reduced with the use of clay liners, even clay-lined lagoons may leak from several hundred to several thousand gallons per acre per day.9

While spills capture public attention, the more common problem is over-application of...
waste onto cropland, which sends polluted runoff into waterways and leaches pollutants into the groundwater.

Too Much Manure on Too Little Land

Animal manure can be a valuable fertilizer source. But the sheer quantity of manure that the byproduct of large-scale animal confinement operations makes it more difficult to apply manure at a rate at which it can be absorbed by crops. The quantity of manure is magnified since feedlots are often clustered in close proximity to each other in small geographic areas in order to be close to slaughterhouses and inexpensive feed supplies.

Applying too much manure to farmland sends pollutants into rivers, streams, groundwater and air, which serves as yet another pathway to water. In a North Carolina state study, nitrate levels in shallow groundwater below fields sprayed with liquid manure have been measured at rates five times the human health standard; in long-term sprayfields, the rates have been as high as thirteen times the human health standard.

Pollutants of Concern

The pollution from animal waste can harm waterways, human health, and aquatic life. The primary pollutants of concern are nutrients (nitrogen and phosphorus), pathogens like bacteria and viruses, and heavy metals.

Phosphorus and nitrogen from manure are major water pollutants. At high levels, phosphorus is acutely toxic to fish; at lower levels, phosphorus and nitrogen over-enrich water bodies, causing an excess of algae (a process called "eutrophication").

Oxygen in water is a basic requirement for a healthy aquatic ecosystem. Severe oxygen depletion usually results when large quantities of organic matter, such as animal manure pollute waterways. Prolonged exposure to low oxygen conditions can suffocate adult fish and their eggs or starve them by killing their prey. An example of the possible harm that may be caused by excessive nutrients is the development of a large oxygen-depleted "hypoxic" area known as the "dead zone" in the Gulf of Mexico. This dead zone, responsible for massive fish kills, now covers extensive areas of the continental shelf south of Louisiana at certain times of the year. Related problems of nutrient enrichment and eutrophication include noxious algae that have toxic effects on marine life. Nutrient pollution has been linked to the growth of a type of organism known as *Pfiesteria piscicida*, which has been implicated in major fish kills in coastal waters in North Carolina. In 1997, *Pfiesteria piscicida* killed more than 30,000 fish in the Chesapeake Bay, whose Eastern Shore suffers from the over-application of poultry manure on farmland. *Pfiesteria* is also toxic to humans.

Ammonia is a toxic form of nitrogen that causes algae blooms and fish kills in coastal waters. Open-air lagoons emit ammonia into the air. Sprayfields and barns also contribute to the problem. Some of the ammonia emitted from factory farms is deposited into waterways or fields about 50 miles away through water or fog, and the rest changes into a airborne form that can travel hundreds of miles away. In Sampson County, North Carolina, the amount of ammonia in the rain doubled between 1985 and 1996, a period of major expansion in the hog industry.

Another pollution concern is the long-term contamination of soil from heavy metals added to livestock feed. For example, zinc and copper are added to swine and poultry feed to prevent disease and improve digestion. Plants absorb a small amount of these metals, but a significant quantity builds up in the soil. When the level gets too high, it can stunt plant growth. Human waste, which is applied to land as sludge, also contains heavy metals, ar
EPA regulations impose restrictions on the permissible level of heavy metals in sludge. These restrictions do not apply to the land application of animal waste, however. In 1985, 17 percent of the soil samples in North Carolina's largest poultry-producing counties and 10 percent of the soil samples in the state's largest swine-producing counties had zinc levels that exceeded by ten times the levels needed by the crops for their growth. The number of soil samples from these counties that exceeded this level had doubled since 1985. Already this level of zinc makes it hard to grow peanuts, and other crops will begin to suffer in future decades as the metals reach higher concentrations. Application onto the land of lagoon sludge, the buildup left on the bottom of the cesspool, poses another environmental threat. Lagoons are abandoned after ten or twenty years and the sludge that has accumulated over the years contains high concentrations of heavy metals, such as zinc and copper, from animal feed.

Human Health Concerns

Human health is also at risk from animal waste pollution. Some of the main concerns include pathogens and excess nitrogen.

Animal waste can contain pathogens (including fecal coliform and other forms of coliform bacteria) that can, for example, contaminate drinking water and cause gastrointestinal illnesses. In some groundwater surrounding factory farms bacteria are present, which demonstrates the potential for microbial contamination. In 1993, cryptosporidium, a pathogen found in Milwaukee's drinking water, made 400,000 people sick and led to the deaths of more than 100 people. A suspected cause was dairy manure.

Pathogens in hog waste are 10 to 100 times more concentrated than they would be in human sewage which is diluted with water in sewage treatment plants. Additionally, human sewage is treated to reduce the nutrients, organic matter and pathogens and is then usually disinfected. In contrast, hog waste is typically stored in anaerobic lagoons, which scarcely reduce the microbial indicators of fecal contamination.

High levels of nitrogen leaching into drinking water supplies increase the risk of methemoglobinemia, or blue-baby syndrome, which can cause deaths in infants. In 1996, the Centers for Disease Control linked the high nitrate levels in Indiana well water near feedlots to spontaneous abortions in humans. High nitrate levels may also foster the growth of harmful organisms like Pfiesteria. In humans, exposure to Pfiesteria toxins in the air or water can cause skin irritation, short term memory loss and other cognitive impairments.

Two studies have looked generally at the medical conditions of residents living near swine factory farms. One survey of residents living in the vicinity of a 2,500-sow facility found much higher reports of respiratory problems than those recorded in neighborhoods of farms where no livestock was raised. Another study from North Carolina found behavior changes in individuals living near large-scale confinement operations.

The intensive use of antimicrobials (including antibiotics) is an integral feature of industrial animal agriculture. Over 40 percent of the antibiotics sold in the United States are used in agriculture, more than 80 percent by weight for growth promotion and the rest for treatment of animal disease. Scientists now believe that agricultural use of antimicrobials has major implications for human health. There is growing evidence that animal use of antimicrobials is tied to the evolution of multiple drug resistance in food-borne disease agents and the loss of efficacy of drugs important in human medicine. Concern about antimicrobial resistance has led scientists and public health officials to advocate curbs on antibiotic use in animal agriculture. The Centers for Disease Control and Prevention (CDC) has also concluded that animal use of antimicrobials has adverse human health consequences and is targeting animal use in its campaign to halt the spread of antibiotic resistance.
Pollution Associated With Poor Siting

Around the nation, lagoons and fields fertilized with manure are sited in locations where pollution is likely to occur. Many states allow lagoons and fields spread with manure to be situated in floodplains and wetlands, and in areas that directly connect to groundwater.

For example, in North Carolina, many factory farms are sited in sandy soils in the coastal plain, in or near "prior converted wetlands" (those drained and converted to agriculture prior to 1985). Although the Clean Water Act exempts these areas from wetlands protections, they still behave like wetlands in many ways; for example, they often have high water tables that may facilitate the overflow of lagoons.

In Kentucky and several other states, factory farms are located in karst terrain—porous, fragile limestone formations that directly connect to groundwater. A burst lagoon in karst areas can put both surface water and groundwater at risk.

Groundwater Depletion

Groundwater depletion is another concern associated with factory farms. Water is used to cool and water the animals and to flush waste from the confinement sites into the lagoon. Additionally, many animals consume large amounts of water. For example, pigs consume from between five to eight gallons of water a day. In Missouri, activists estimate that a swine operation that finishes 80,000 animals per year consumes over 200,000 gallons of water per day, or 73 million gallons per year.  

Air Pollution

The air quality problems associated with large-scale confinement operations include emissions of hydrogen sulfide, ammonia and methane.

Methane is a potent greenhouse gas implicated in global climate change. A commonly used manure "treatment" technology is anaerobic lagoons, which reduce the nutrient content of the waste but produce methane gas as a byproduct. EPA estimates that emissions from manure management were about ten percent of total U.S. methane emissions in 1995, and about thirty percent of the agricultural sector's emissions. Of those emissions, liquid-based manure management systems such as those found in factory farms accounted for over eighty percent of the total emissions from animal wastes.

Hydrogen sulfide is a toxic gas associated with the decomposition of swine manure. Emissions of this gas turned out to be the cause of dizziness, nausea, vomiting and blackouts for residents of Renville County, Minnesota, living near factory farms. Initial tests by the Minnesota Pollution Control Agency in that county found that public health standards for hydrogen sulfide were exceeded by half of the ten facilities tested, some by up to 50 times the state standard.

Conclusion

Factory farms have polluted our surface waters, our groundwater and our air. Moreover, public health is being threatened. It's time to recognize the damage that animal factories
are wreaking on our environment.

Notes


9. Correspondence from Dennis Ramsey, North Carolina Department of Health and Natural Resources, to Karen Priest (May 19, 1997).


APPENDIX R
Fields of Poison

California Farmworkers and Pesticides

by

Margaret Reeves and Kristin Schafer
Pesticide Action Network North America

Kate Hallward
United Farm Workers of America

Anne Katten
California Rural Legal Assistance Foundation

CPR

One in a series of reports by Californians for Pesticide Reform

001592
Californians for Pesticide Reform

Californians for Pesticide Reform (CPR) is a coalition of public interest organizations committed to protecting public health and the environment from pesticide proliferation. CPR's mission is to 1) educate Californians about environmental and health risks posed by pesticides; 2) eliminate the use of the most dangerous pesticides in California; and 3) promote sustainable pest control solutions for our farms, communities, forests, homes and yards; and 4) hold government agencies accountable for protecting public health and Californians' right to know about pesticide use and exposure.

For more information on pesticides and how you can work to reduce pesticide use and protect your health and environment, contact CPR.

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California Rural Legal Assistance Foundation

The California Rural Legal Assistance Foundation (CRLAF) is a private, non-profit organization dedicated to providing advocacy and educational assistance to farmworkers adversely affected by pesticide exposure and other work health and safety hazards. The Projects' work includes monitoring of employer compliance with CalOSHA standards and CalOSHA enforcement activities; oversight of pesticide exposure investigations and DPR policy development and implementation; and advocacy for improved pesticide exposure protections for workers and elimination of use of the most hazardous pesticides.

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Pesticide Action Network North America

The Pesticide Action Network (PAN) advocates adoption of ecologically-sound pest management methods in place of pesticide use. For 17 years, our international network of over 400 citizen groups in more than 60 countries has created a global citizen pesticide reform movement with regional coordinating centers in Africa, Asia, Europe, Latin America and North America. PAN North America's (PANNA) primary approach is to link the collective strengths and expertise of groups in Canada, Mexico and the U.S. with counterpart citizen movements in other countries, and to carry out joint projects to further our collective goals of sustainable agriculture, environmental protection, workers' rights, improved food security, and guaranteed human rights for all.

For more information and to order copies of this report, contact Pesticide Action Network.

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United Farmworkers of America, AFL-CIO

The United Farm Workers of America, AFL-CIO, is the largest union of farmworkers in the country, with regional offices throughout California and in Texas, Florida and Washington State. Founded by Cesar Chavez and Dolores Huerta in 1963, the union now has 27,000 members and has won 18 elections since 1994. Because farmworkers are the single population most affected by pesticides, the UFW plays a central role in advocating for the ban of the most dangerous pesticides and for farmworkers' rights to a safe and healthy work place. The UFW approaches pesticide issues from an organizing perspective, and works with groups throughout North America who have joined the fight to improve the lives of millions of agricultural workers in the U.S.

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Many individuals contributed their time and expertise to this report. Research assistance, including data collection and fact checking, was provided by Christine Lee and Lars Neumeister (Pesticide Action Network).

Rupali Das, MD (California Department of Health Services), Shelly Davis (Farmworker Justice Fund, Inc.), Marion Moses, MD (Pesticide Education Center), Salvador Sandoval, MD (Merced, CA physician) and Gina Solomon, MD (Natural Resources Defense Council) reviewed a draft manuscript of the report and provided valuable comments and insights. Additional useful suggestions were made by Californians for Pesticide Reform (CPR) staff members David Chatfield and Joanie Clayburgh and by staff at CPR member organizations, including Martin Bouque (Institute for Food and Development Policy—Food First), Karen deMoor and Ellen Hickey (Pesticide Action Network).

Initial drafts of the manuscript were reviewed by the authors' colleagues in each organization, including Marcia Ishii-Eireman (Pesticide Action Network); Michael Meurer, Eileen McCarthy, César Hernández and Emanuel Benitez (California Rural Legal Assistance, Inc.); Lori Schiraga (Environmental Defense Center); and UFW staff (United Farm Workers of America).

The report was formatted by Brenda Willoughby (Pesticide Action Network). The Spanish translation was provided by Víctor Reyes. Final editing and proofing were provided by Marcia Ishii-Eireman, Steve Scholl-Buckwald, Amy Cohen, Ama Marston, Martha Garcia and Michele Wright.

The authors bear responsibility for any factual errors. The recommendations are those of Pesticide Action Network North America, the California Rural Legal Assistance Foundation, United Farmworkers of America and Californians for Pesticide Reform. The views expressed are those of the authors and do not necessarily reflect the views of our funders.

This report was supported by The California Endowment, The California Wellness Foundation, Clarence E. Heller Charitable Foundation, Columbia Foundation, Charles Stewart Mott Foundation, Foundation for Deep Ecology, The Pew Charitable Trusts, Richard and Rhoda Goldman Fund, Tides Center and Turner Foundation. Additional support for Pesticide Action Network's program on workers' rights was provided by Warsh-Mott Legacy and Turner Foundation.

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This report is dedicated to the thousands of farmworkers who labor in California's agricultural fields.
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Fields of Poison
California Farmworkers and Pesticides

Authors
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Kate Hallward, United Farm Workers of America
Anne Kanten, California Rural Legal Assistance Foundation

Executive Summary

Agriculture is still one of the most hazardous occupations in the U.S. The death rate among agricultural workers nationwide was an estimated 20.9 per 100,000 workers in 1996 compared to the average for all industries of 3.9 per 100,000 workers. In addition to long workdays and high risk of physical injury, the nation’s estimated 2.5 million farmworkers face a greater risk of pesticide exposure than any other segment of the population.

In California, the state with the largest agricultural economy in the country, farm work is conducted by a workforce of about 600,000 men and women. From 1991 to 1996 the California Environmental Protection Agency’s Department of Pesticide Regulation (DPR) reported 3991 cases of occupational poisoning by agricultural pesticides, an average of 665 cases per year.

Unfortunately, the situation is even worse than these numbers indicate. Pesticide exposure incidents often go unreported because many farmworkers are afraid of incurring medical bills since few have health insurance and many do not realize they are entitled to Workers’ Compensation. Many workers fear retaliation from employers or are not provided sufficient pesticide hazard training to recognize symptoms of pesticide poisoning. Some farmworkers bear the symptoms they experience simply as part of the job.

Farmworker Poisoning Data Limited
Since the 1980s, California has had unique reporting systems for both pesticide use and pesticide-related illnesses. These data collection systems are intended to assist policy makers and the public in understanding the scope of pesticide use and poisonings in the state. Our attempts to use these data to understand farmworker exposure to pesticides, however, have uncovered significant limitations in the reporting systems.

Gaps in pesticide illness data, for example, limit efforts to pinpoint with certainty which crops and which pesticides used in production of those crops are responsible for the greatest number of farmworker poisonings. Nearly a third of the reported cases between 1991 and 1996 identify no specific crop associated with the poisoning incident. Many case reports contain little or no information on specific pesticides involved, type of work, symptoms or medical tests. This is partly because many doctors know little about pesticide poisoning and many are not filing required pesticide illness reports with county officials, so the opportunity for immediate investigation is lost.

In addition, the California pesticide illness reporting system addresses only acute health effects. Chronic effects are not accounted for, despite evidence that farm work is associated with elevated risk of certain cancers, birth defects, spontaneous abortion and developmental problems.

Despite these limitations, the data collected through California’s pesticide use and pesti-
cide illness reporting systems reveal disturbing trends, including increasing use of pesticides and continued high numbers of pesticide poisonings.

Reported Poisonings by Crop, Activity and County

Ten crops account for half of all reported agriculture-related pesticide illnesses (Table I). All other identified crops account for about 22% of reported illnesses, and in about 29% of the cases no specific crop was identified.

The majority of pesticide poisonings occur when farmworkers are doing fieldwork, such as picking, field packing, weeding, and irrigating. From 1991 to 1996 the two most common sources of exposure leading to pesticide-related illnesses were drift from pesticide spraying (44%) and field residues (33%).

The greatest number of poisonings were reported in Kern County (534), with a majority occurring in cotton and grapes. The 15 counties with the most reported pesticide-related poisonings are listed in Table II. In nine of those counties, the majority of reported poisonings had no specific crop listed as a source, severely limiting efforts to target regulatory actions to the most problematic crops. Data from all 48 counties in which pesticide poisonings were reported are listed in Appendix F.

Many Poisonings Are Not Reported

California's Pesticide Illness Surveillance Program offers a limited view of the extent of farmworker pesticide exposure. Although it is the most extensive reporting system in the U.S., many agricultural poisoning cases are never reported. The primary barriers to accurate reporting are intimidation from employers and fear of job loss. The following excerpt from a farmworker interview illustrates the extent of employer intimidation in some cases:

When Magdalena fell ill during her work as a picker at a large strawberry farm in Watsonville, California, she told her foreman that her spreading rash was a result of pesticide exposure. She was grudgingly given permission to go to the company doctor, with the understanding that she would have to pay for the visit herself if the doctor did not declare her illness to be pesticide related. Within days, the worker was fired with only the explanation that she "wasn't pulling enough into her work."

Retaliation against injured workers is illegal but all too common, and can have a chilling effect on an entire workforce. Federal and state laws prohibit retaliation against workers who are exercising their rights, but until the laws are effectively enforced, they offer little consolation to an injured—or fired—worker.

<table>
<thead>
<tr>
<th>County</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern</td>
<td>534</td>
</tr>
<tr>
<td>Fresno</td>
<td>515</td>
</tr>
<tr>
<td>Monterey</td>
<td>428</td>
</tr>
<tr>
<td>Tulare</td>
<td>399</td>
</tr>
<tr>
<td>San Joaquin</td>
<td>200</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>180</td>
</tr>
<tr>
<td>Kings</td>
<td>167</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>138</td>
</tr>
<tr>
<td>Imperial</td>
<td>128</td>
</tr>
<tr>
<td>Merced</td>
<td>127</td>
</tr>
<tr>
<td>Ventura</td>
<td>119</td>
</tr>
<tr>
<td>San Diego</td>
<td>114</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>84</td>
</tr>
<tr>
<td>Madera</td>
<td>79</td>
</tr>
<tr>
<td>Riverside</td>
<td>77</td>
</tr>
</tbody>
</table>

Source: California DPR 1999.

Table I. Acute Poisoning Cases—Top 10 Crops, 1991–1996

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>grapes</td>
<td>539</td>
</tr>
<tr>
<td>cotton</td>
<td>399</td>
</tr>
<tr>
<td>broccoli</td>
<td>307</td>
</tr>
<tr>
<td>oranges</td>
<td>165</td>
</tr>
<tr>
<td>ornamentals</td>
<td>104</td>
</tr>
<tr>
<td>almonds</td>
<td>102</td>
</tr>
<tr>
<td>romaine</td>
<td>102</td>
</tr>
<tr>
<td>lettuce</td>
<td>101</td>
</tr>
<tr>
<td>strawberries</td>
<td>78</td>
</tr>
<tr>
<td>alfalfa</td>
<td>70</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1967</td>
</tr>
<tr>
<td>all other crops*</td>
<td>880</td>
</tr>
<tr>
<td>no crop given</td>
<td>1144</td>
</tr>
<tr>
<td>Total</td>
<td>3991</td>
</tr>
</tbody>
</table>

*For a list of all crops included, see Appendix C.

Source: California DPR 1999.
Enforcement of Laws is Weakest in Areas of High Pesticide Use

California’s county-based system for enforcing pesticide laws has serious weaknesses. A few counties do conduct fairly thorough inspections and investigations and issue fines for violations quite regularly. Unfortunately, these counties are the exception rather than the rule.

By comparing the five counties issuing the greatest number of fines to the five counties reporting the most agricultural pesticide use for 1995, it is evident that counties with greater agricultural pesticide use and more cases of agricultural pesticide illness issue very few fines (Table III). No county in the Central Valley, the state’s agricultural heartland, issued more than an average of 25 fines per year. In contrast, primarily urban Los Angeles County issued an average of 124 fines annually. (See Appendix I for the enforcement record of all counties.)

Statewide, county agricultural commissioners issue fines for about a tenth of the violations.

Table III. Top 5 Counties for Agricultural Pesticide Fines vs. Top 5 Counties for Pesticide Use

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>124</td>
<td>208</td>
<td>8</td>
</tr>
<tr>
<td>Orange</td>
<td>53</td>
<td>994</td>
<td>6</td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td>42</td>
<td>161</td>
<td>2</td>
</tr>
<tr>
<td>Sacramento</td>
<td>43</td>
<td>2,429</td>
<td>5</td>
</tr>
<tr>
<td>Riverside</td>
<td>40</td>
<td>4,471</td>
<td>5</td>
</tr>
<tr>
<td>Kern</td>
<td>24</td>
<td>24,108</td>
<td>268</td>
</tr>
<tr>
<td>Fresno</td>
<td>19</td>
<td>39,805</td>
<td>99</td>
</tr>
<tr>
<td>Tulare</td>
<td>17</td>
<td>17,927</td>
<td>43</td>
</tr>
<tr>
<td>Monterey</td>
<td>12</td>
<td>10,122</td>
<td>50</td>
</tr>
<tr>
<td>San Joaquin</td>
<td>8</td>
<td>11,646</td>
<td>30</td>
</tr>
</tbody>
</table>

*1996 pesticide use data have not yet been officially released by DPR. Use is listed as thousand pounds of active ingredients.

**1996 pesticide use data have not yet been officially released by DPR. Use is listed as thousand pounds of active ingredients.

Source: Data from California DPR 1996a; Pesticide use data from Lehrman 1997; illness data from California DPR 1997.

When fines are issued, they are generally very low. Of the fines issued from 1991 through 1996, almost half were less than $151, and less than 5% exceeded $1,000. The large fines issued generally result from investigations of episodes of pesticide drift or early field reentry affecting large crews of workers. This approach is analogous to the highway patrol issuing speeding tickets only when a huge pile-up occurs, and just sending a letter that says, “Please don’t speed,” to other violators.

Recommendations

The most important and urgently needed step to reduce exposure is eliminating use of those pesticides which endanger the health and well-being of farmworkers throughout the state. Farmworker experiences show that even pesticide applications which follow the letter of the law can result in exposure or illness. Phasing out use of the most dangerous pesticides—those that cause cancer or reproductive harm, or are extremely toxic to the nervous system—would represent a tremendous step toward a more sustainable, healthy and humane agricultural system.

To achieve this goal and reduce the level of farmworker exposure to those pesticides which remain registered, we recommend that state agencies take the following steps:

1. Rapidly phase out use of the most toxic pesticides and promote healthy and sustainable alternatives. California’s Department of Pesticide Regulation (DPR) should develop and implement a plan to phase out use of pesticides that cause can-
cer or reproductive harm, or are highly poisonous acute nerve toxins. The California Environmental Protection Agency and the California Department of Food and Agriculture should commit significant resources to research and training in support of organic and other sustainable agricultural practices.

2. Improve regulations to reduce farmworker exposure. DPR should take a number of immediate steps, including banning aerial spraying of pesticides, prohibiting backpack spraying for restricted use pesticides, and expanding buffer zones and posting and notification requirements.

3. Strengthen enforcement of existing laws. DPR should abolish the option of issuing notices of violation that carry no fine, set minimum mandatory penalties, increase fine levels for moderate and serious violations, and abolish leniency toward violators who claim to be unfamiliar with regulatory requirements. An independent review board should be established to evaluate the performance of county agricultural commissioners in enforcing pesticide regulations.

4. Improve reporting of pesticide poisonings. The Department of Health Services should expand its existing program to train doctors about pesticide poisoning diagnosis, treatment and reporting requirements, and should establish and fund a program to monitor long-term health impacts of pesticide exposure among farmworkers. California Occupational Safety and Health Administration (CalOSHA) and the Medical Board of California should exercise their authorities to fine doctors who fail to report pesticide poisonings promptly to county health officers. In addition, “safety incentive” contests which provide bonuses or prizes to work-crews when no injuries or illnesses are reported should be prohibited.

5. Improve farmworker access to medical treatment. Existing regulations requiring employers to take workers promptly to a doctor if pesticide poisoning is suspected should be enforced. Funding for migrant clinics and other health care providers for farmworkers should be increased, and agricultural employers should provide health insurance and/or establish a fund to finance farmworker health care costs.

6. Ensure farmworker and public right-to-know. DPR should expand workers’ right-to-know by requiring adequate posting of restricted entry intervals and descriptions of acute and chronic health effects associated with each pesticide applied, both in an understandable format and language. Farmworkers should also be guaranteed “adequate warning” about exposure to carcinogens and reproductive toxins as required under Proposition 65, and DPR should establish a public database with information on the amount of pesticides used, violations reported, number of workers affected by the violations and the number of pesticide illnesses for each user/grower. These data should be released to the public no more than six months after the end of the year for which the information is reported to DPR.
Introduction: Farmworkers on the Frontline of Pesticide Exposure

"I have had headaches, dizziness, nausea, stomach pain and vomiting because I was poisoned by pesticides at work. I told the foreman how I felt and he told me that I was drunk. He ignored me and left. I am the pesticide sprayer and I often get wet with the liquid that they use on the plants. My clothing does not protect me, it is too thin and my arms get wet. I can never go to the doctor because I don’t have enough money.”

—Julio

Agricultural Work Is Dangerous

Agriculture is still one of the most hazardous occupations in the U.S. The death rate among agricultural workers nationwide was an estimated 20.9 per 100,000 workers in 1996, compared to the average for all industries of 3.9 per 100,000 workers (National Safety Council 1996). Rates of injury or illness among farmworkers are also high. Since 1990, injury rates in agricultural production have ranged from 9.4% to more than 12%, well above the average of occupational injuries for all industries (6.6% in 1996) (AFL-CIO 1999, Bureau of Labor Statistics 1995, Runyan 1993).

In addition to long workdays and high risk of physical injury, the nation’s estimated 2.5 million farmworkers face a greater risk of pesticide exposure than any other segment of the population. Agricultural workers may be directly exposed to pesticides in many ways—mixing or applying pesticides; during planting, weeding, thinning, irrigating, pruning and harvesting crops; or living in the midst of treated fields. Government estimates indicate that more than 20,000 farmworkers suffer from acute pesticide poisonings each year in the U.S. (Blondell 1997, Federal Register 1987, U.S. GAO 1992).

Agricultural work in the U.S. is performed primarily by members of ethnic or racial minorities. About 79% of migrant and seasonal farmworkers in the country are Latino—the vast majority of Mexican origin, 3% Puerto Rican and a small proportion from other Latin American countries. European Americans make up about 18% and African and Asian Americans make up the remainder (Mines et al. 1997).

Children Are More Vulnerable to Pesticide Exposure

Children are disproportionately exposed to many environmental toxins, including pesticides. Those who live on or near farms or have family members who work on farms generally experience greater exposure than the "average" child. In addition, children are generally more susceptible to the effects of pesticides than adults.

According to a recent study of pesticide-related health risks of farm children (Solomon and Mett 1998), three major factors are particularly important. Compared to adults:

- Children drink more fluids, breathe more air, and eat more food per unit of body weight so their potential for exposure is proportionately greater.
- Children often have greater contact with environmental contaminants because of activities which involve contact with soil and floor surfaces, and hand-to-mouth behavior.
- Because children's bodies and brains are immature and still growing and developing, environmental toxins can have more serious effects on children.

Childhood cancers are also a major concern. There is evidence of associations between prenatal or infant exposures to pesticides and childhood brain tumors, leukemia, non-Hodgkin's lymphoma, sarcoma, and Wilms' tumor. Solomon and Mett cite a California study in which use of pesticides in the home or garden during pregnancy or lactation was associated with a more than threefold increased risk of childhood leukemia.
In addition to the adult workforce, the U.S. farm labor workforce includes an estimated 300,000 children between the ages of 14 and 17; no estimates are available for younger children (Dobnik and Anthony 1997, U.S. GAO 1998). These young people are particularly vulnerable to pesticide exposure (see box on previous page).

Agricultural work is also poorly compensated. Nationwide, 62% of farmworkers live in poverty, with median seasonal incomes as low as $2,500 for farmworker women and $5,000 for farmworker men (Mines et al. 1997). In California, where the growing seasons stretch through most of the year, annual farmworker income is slightly higher, averaging between $5,000 and $7,500 (Rosenberg et al. 1998).

Economic insecurity, poor housing, language barriers, lack of health insurance, and poor work conditions exacerbate the problems of pesticide exposure for most farmworkers. Recommendations to bathe at the end of each workday, wear clean work clothes every day and wash work clothes separately from family clothes ring hollow when one’s living quarters have no running water or washing machine. At least 800,000 farmworkers across the country lack adequate shelter and may be found camping in parking lots, living in their cars or in groups of 10 to 12 in trailers, or occupying garages, tool sheds, caves, tents and hotel rooms (Greenhouse 1998).

**Laws Provide Limited Protection for Farmworkers**

Farmworkers have historically been excluded from basic protections that workers in other industries have enjoyed for decades. In many states farmworkers are denied the right to organize, Workers’ Compensation for workplace injuries, and higher pay for overtime work. Farmworkers are specifically denied protection of the right to organize under the National Labor Relations Act, and only some states, including California, have enacted Agricultural Labor Relations Acts to fill this void.

In 1992, the U.S. Environmental Protection Agency (EPA) established the Worker Protection Standard (WPS) to implement its mandate “to reduce the risks of illness or injury resulting from workers’ and handlers’ occupational exposures to pesticides” (U.S. EPA 1992). The WPS includes information and training requirements, posting and restricted entry rules for fields where pesticides are applied, and requirements for other specific measures to ensure safety of workers. Federal law allows each state to enforce these protections if adequate laws, regulations and enforcement procedures are adopted at the state level.

Enforcement of the national WPS and state safety regulations is uneven, and many loopholes and exclusions exist (Moses 1989, Sandoval 1999). California, for example, has had pesticide safety regulations in place for more than 25 years, yet the majority of violations documented by county officials between 1991 and 1997 resulted in no penalty or fine, and pesticide illnesses and injuries among farmworkers have not declined since 1991.

**California Farmworkers Are Routinely Exposed to Toxic Pesticides**

In California, the state with the largest agricultural economy in the country, farm work is conducted by a workforce of about...
600,000 men and women (Department of Health and Human Services 1990). Accurate information on the ethnic breakdown of this workforce does not exist. Although the average annual income of California farmworkers is slightly higher than the national average, the cost of living in many agricultural areas is also high. Many farmworkers live in "labor camps," where large families often share one- or two-room shelters near agricultural fields.

Jobs performed by farmworkers in California range from field preparation to planting, weeding, irrigating, pruning, harvesting and product packaging. Many of California's specialty crops (e.g., strawberries, grapes, broccoli, cut flowers) require labor-intensive field preparation, maintenance and harvesting—in contrast to the highly mechanized production of field crops such as wheat and soybeans. This labor-intensive management increases the potential for direct farmworker contact with pesticides at many stages, including soil preparation with chemical fumigants; overhead application of insecticides, herbicides, and fungicides; dusting plants with pesticides prior to harvest; and postharvest treatment and handling. Farmworkers are often responsible for mixing and applying pesticides and are also exposed during and following application both in fields where they work and from application in neighboring fields.

*As a strawberry worker, I feel like pesticides are all around me: in the fields I pick, in the fields all around them, and from the fields that surround my home. Sometimes at work, they give us cream for our hands to use after they spray. I get rashes on my hands and arms, and my eyes get red and sore. Sometimes, when I come home from work, I can smell the chemicals in my clothes. My house is surrounded by lettuce fields which are also sprayed with pesticides, and about 100 yards away, there is a strawberry field which has recently been fumigated with methyl bromide. Right now, the tarp they use to keep the chemical in the earth are all peeling up and blowing in the wind.*

—Carlos

Low income and fear of job loss provide strong incentives to stay on the job rather than take time off to visit the doctor when pesticide poisoning is suspected. Pesticide incidents in California often go unreported because many farmworkers do not have health insurance, fear retaliation from employers or are not provided sufficient pesticide hazard training to recognize symptoms of pesticide poisoning. Other barriers, such as insufficiently trained health care professionals who fail to recognize pesticide poisoning, reduce the official rate of reporting still further. Many farmworkers consider the symptoms they experience simply part of the job.

As Carlos' experience illustrates, farmworkers are also exposed to pesticides in and around their home, both through residue on clothing and drift from farm fields which surround rural neighborhoods in many agricultural regions. This cumulative exposure is not taken into consideration when setting standards for "safe" levels of worker exposure to pesticides, which assume that workers will only be exposed to a pesticide in the field. In addition, state farmworker safety regulations are poorly enforced and buffer zones in agricultural work areas around fumigated fields are much smaller than those around rural residences.

This report was produced as a collaborative effort by Pesticide Action Network North America, the United Farm Workers and California Rural Legal Assistance Foundation, all members of Californians for Pesticide Reform. The report:

* highlights the dangers faced daily by thousands of farmworkers who labor in California's agricultural fields;

* explores failings of the regulatory system designed to protect farmworkers from pesticide exposure;

* recommends steps for improving the regulatory system; and

* proposes ways to move toward an agricultural system that is less reliant on the chemicals that pose serious danger to the industry's workers, consumers, and the environment.
Reported Pesticide Exposure Among California Farmworkers

Laura, a farmworker from Lamont, California, is a widow and mother of five. She and her oldest daughter are the sole providers for the family. Laura has been a farmworker for the last ten years working throughout the Northwest. Most recently, she has worked in California grape fields. When asked if she ever felt ill in the fields, Laura responds:

"Yes, I have felt sick. I have had headaches, felt dizzy and nauseated. However, I never went to the doctor because the symptoms would go away."

"About a year and a half ago when I was working, I had a very bad headache and felt like vomiting. Then I kept having to scratch my hands. A few days later, I noticed that I had a rash on my hands and neck. I figured the rash would go away on its own. But when it didn’t, I told the foreman, and he sent me to the doctor. The company doctor told me that I had an allergic reaction, and prescribed some pills and a lotion for the rash. I had to miss one day of work. I know that if I don’t work I don’t get paid so I prefer to go to work. I found out that other workers also had rashes on their hands. I don’t know if they ever went to the doctor."

Since the 1980s, California has had unique reporting systems for both pesticide use and pesticide-related illnesses managed by the Department of Pesticide Regulation (DPR). These two reporting systems are key elements of California’s regulatory program, a program widely considered the most extensive in the world (Maddy et al. 1990). The systems are designed to assist policy makers and the public in understanding the scope of pesticide use and poisoning in the state. Attempts to use the reporting systems’ data to evaluate farmworker exposure to pesticides, however, have revealed significant limitations of both systems.

For example, California’s pesticide use reporting system only requires reporting of pesticide active ingredients. “Inert” ingredients are excluded from reporting requirements, despite their large volume in pesticide formulations and their potential or known toxicity (Liebman 1997). Pesticide illness data are also incomplete. Nearly a third of the reported cases between 1991 and 1996 identify no specific crop associated with the poisoning incident. Many case reports contain little or no information on the type of pesticide used, pesticide exposure level, or the duration of exposure.

How the Pesticide Illness Surveillance Program Works

California’s Pesticide Illness Surveillance Program (PISP) requires physicians to report to county health officers any illnesses they know or suspect are related to pesticide exposure. County health officers must then report to county agricultural commissioners. The commissioners (trained by DPR) determine whether the cases identified are potentially related to pesticides. DPR staff then review commissioner reports and categorize incidents based on their interpretation of the relation between the illness or injury and pesticide exposure. A data set is then compiled which includes information on type of illness reported (listed as eye, skin, respiratory and systemic—including nausea and headache), allergic response, and type of exposure (principally residue, drift or application).

DPR also reviews doctors’ reports filed with Workers’ Compensation claims for evidence of pesticide involvement. According to DPR officials, the majority of pesticide illness data are actually obtained from Workers’ Compensation reports rather than pesticide illness reports (California DPR and ACSA 1994). This illustrates major weaknesses in the system. Many physicians do not file pesticide illness reports as required under the PISP. Information included in reports filed for Workers’ Compensation (“Doctor’s First Report of Occupational Illness or Injury”) may include less information than is required in the pesticide illness reports. In addition, DPR generally reviews the Workers’ Compensation reports months after incidents occur, when supportive testing for pesticide residues is no longer possible. And finally, perceived lack of coverage under Workers’ Compensation may discourage farmworkers from seeking medical attention and further limit documentation of poisonings.
no information on specific pesticides involved, making it virtually impossible to determine which pesticides are associated with reported illnesses.

In addition, the California pesticide illness reporting system addresses only acute health effects. Chronic effects are not accounted for, despite evidence that farm work is associated with elevated risk of certain cancers, birth defects, spontaneous abortion and developmental problems (see "Chronic Effects of Pesticide Exposure," below). Other barriers to accurate accounting of pesticide illness include misdiagnoses by physicians (Goldman 1998) and employment discrimination toward workers reporting pesticide illnesses.

Despite these limitations, the data collected through California's pesticide use and pesticide illness reporting systems reveal disturbing trends, such as growing reliance on toxic pesticides and continued high numbers of pesticide poisonings.

Pesticide Use Is Rising

From 1991 to 1995, pesticide use in California increased, despite growing public interest in pesticide-free organic food. During this period, pesticide use in production agriculture increased 37% to more than 192 million pounds of active ingredient (Liehman 1997). Pesticide use data for 1996-1998 are not yet available.

During the 1991–1995 period, use of the most toxic pesticides increased as well. This category includes cancer-causing pesticides, restricted use pesticides, acute nerve toxins and endocrine disruptors which increased by 129%, 33%, 22% and 17%, respectively (Table 2.1). Appendix B lists these most toxic pesticides, plus developmental and reproductive toxins, and extremely toxic systemic poisons used during this period. As use of these toxic pesticides increases, so too does the risk of exposure among the farmworker population.

Reported Farmworker Poisonings by Crop, Activity and County

Reported pesticide-related illnesses are not declining in California. DPR reviews about 2,000 potential pesticide poisoning cases every year. From 1991 to 1996 this included 3,991 cases related to pesticide use in agriculture, an average of 665 cases per year. Although the numbers of reported cases were lower in 1993 and 1994 compared to the previous two years, reported cases increased again in 1995 and 1996 to 721 and 761, respectively. (See Appendix A for explanation of data analyses.)

In 1996, in a particularly severe incident in Kern County, 230 grape workers were poisoned by drift from aerial spraying in an adja-

Group Poisonings Are Common

Farmworker poisonings do not occur as a series of isolated individual events. Rather, group poisoning events are common. From 1991 to 1996, 32 group poisoning incidents involving ten to 29 workers were reported, six incidents involving 30 to 49 workers, and three incidents involving 50 to 79 workers. The two recent events below illustrate group poisoning scenarios.

* In July 1998, 36 farmworkers, including a 13 year-old boy, became ill while weeding cotton near Firebaugh, California. Thirty were taken immediately to a nearby clinic. The cotton field had been treated with the toxic pesticide carbofuran at 4 am and they began four hours of work at 6 am. Although carbofuran has a restricted entry interval of 48 hours and requires both posting of treated fields and verbal notification of workers, neither was provided (CDC 1999).
* In September 1996, 22 farmworkers, including three pregnant women, were taken to a hospital after being poisoned while harvesting grapes near Bakersfield, California. An additional 225 farmworkers were also exposed when a crop duster sprayed a nearby cotton field with a mixture of toxic pesticides including Lorsban, one of the most widely used insecticides in the U.S. and a leading cause of pesticide poisonings (California OSHA 1997, PAN 1996).

1 A restricted entry interval (REI) is the period of time required between pesticide application and allowable reentry into a field for hands-on labor such as weeding and harvesting.
cent cotton field. Although this was an unusually large group, such clusters ("group poisonings") are not uncommon. Group poisonings occurred in all six years (see box on previous page).

**Grapes, Cotton and Broccoli Are Most Dangerous Crops**

Ten crops account for nearly half of all reported agriculture-related pesticide illnesses: grapes, cotton, broccoli, oranges, ornamentals, almonds, tomatoes, lettuce, strawberries and alfalfa (Table 2.2). All other crops account for about 22% of reported illnesses, and in about 29% of the cases no specific crop was identified. (See Appendix C for a list of all crops in which poisonings were reported.) Pesticide use data are included in Table 2.2 for nine of the 10 crops listed. Statistical analysis shows a positive relationship between the amount of pesticides used on a particular crop and number of reported illnesses associated with that crop.10

Gaps in available data limit efforts to pinpoint with certainty which crops and which pesticides used in production of those crops are responsible for the greatest number of farmworker poisonings. The high proportion of cases in which no specific crop was identified (29%) makes it impossible to determine whether some crops account for even more poisonings than the data suggest, or whether additional incidents are more evenly distributed among all crops.11 Furthermore, since data are not available on workforce size for specific crops, the proportion of farmworker poisonings relative to the total workforce for each crop remains unknown.

Similarly, limited data prevent clear identification of specific pesticides directly responsible for farmworker poisoning incidents. While overall pesticide use data are available by crop, data are incomplete with respect to which pesticides may have been associated with reported acute illnesses. Most reported poisoning cases list several possible poisoning agents. Of the 246 compounds listed as possible poisoning agents from 1991 to 1996, 71 (29%) appear on the list of most toxic pesticides in Appendix B. In actual practice these most toxic pesticides constitute a disproportionately large share (43%) of compounds used in the ten crops with the worst record of poisonings (Appendix D). This suggests that as the level of pesticide toxicity increases, so too does the incidence and risk of poisoning.

**Table 2.1. Reported Use of Toxic Pesticides in California, Summary 1991-1995**

<table>
<thead>
<tr>
<th>Pesticide Category</th>
<th>Change between 1991 and 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted Use Pesticides</td>
<td>Increased 33% to 48.0 million lbs./year</td>
</tr>
<tr>
<td>Acute Systemic Toxins*</td>
<td>Steady at about 30 million lbs./year</td>
</tr>
<tr>
<td>Carcinogens</td>
<td>Increased 129% to 23.4 million lbs./year</td>
</tr>
<tr>
<td>Reproductive Toxins</td>
<td>Steady at about 18 million lbs./year</td>
</tr>
<tr>
<td>Endocrine Disruptors</td>
<td>Increased 17% to 15.3 million lbs./year</td>
</tr>
<tr>
<td>Nerve Toxins**</td>
<td>Increased 21% to 6.8 million lbs./year</td>
</tr>
<tr>
<td>Total Reported Pesticide Use***</td>
<td>Increased 30% to 208.8 million lbs./year</td>
</tr>
</tbody>
</table>

* Defined by the U.S. EPA as Category I acute systemic toxins. ** Defined by the U.S. EPA as Category II nerve toxins. *** Use includes production agriculture, postharvest treatment, structural pest control and landscape uses.

Source: Lieberman 1997. Some figures were updated using corrected data from California DPR (1998b).

**Drift and Residues Cause Most Farmworker Poisonings**

The majority of pesticide poisonings occur when farmworkers are doing fieldwork, such as picking, field packing, weeding, and irrigating. From 1991 to 1996 the two most common sources of exposure leading to pesticide-related illnesses were drift from pesticide spraying (44%) and field residues (33%) (Figure 2.1).

The fact that drift exposure is common indicates that some common application methods, such as aerial spraying and air-blast application, have a propensity to drift off target. Lack of posting and notification requirements when adjacent fields are scheduled for spraying puts fieldworkers in danger as well. The high incidence of field residue exposures indicates that restricted entry intervals (REIs) and field postings—designed to protect workers from residues—are inadequate and/or unenforced.

Gaps in available data limit efforts to pinpoint with certainty which crops and which pesticides used in production of those crops are responsible for the greatest number of farmworker poisonings.
### Table 2.2. Acute Poisoning Cases—Top 10 Crops, 1991–1996

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total Cases</th>
<th>'91</th>
<th>'92</th>
<th>'93</th>
<th>'94</th>
<th>'95</th>
<th>'96</th>
<th>Million lbs. Active Ingredient (1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>grapes</td>
<td>539</td>
<td>102</td>
<td>107</td>
<td>81</td>
<td>54</td>
<td>125</td>
<td>70</td>
<td>58.7</td>
</tr>
<tr>
<td>cotton</td>
<td>399</td>
<td>14</td>
<td>44</td>
<td>8</td>
<td>53</td>
<td>23</td>
<td>257</td>
<td>17.7</td>
</tr>
<tr>
<td>broccoli</td>
<td>307</td>
<td>115</td>
<td>63</td>
<td>2</td>
<td>6</td>
<td>80</td>
<td>41</td>
<td>1.3</td>
</tr>
<tr>
<td>oranges</td>
<td>104</td>
<td>23</td>
<td>25</td>
<td>14</td>
<td>12</td>
<td>23</td>
<td>7</td>
<td>3.4**</td>
</tr>
<tr>
<td>ornamentals</td>
<td>180</td>
<td>22</td>
<td>15</td>
<td>8</td>
<td>23</td>
<td>8</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>almonds</td>
<td>102</td>
<td>18</td>
<td>15</td>
<td>36</td>
<td>10</td>
<td>8</td>
<td>15</td>
<td>12.0</td>
</tr>
<tr>
<td>tomatoes</td>
<td>78</td>
<td>14</td>
<td>22</td>
<td>16</td>
<td>7</td>
<td>5</td>
<td>14</td>
<td>7.1</td>
</tr>
<tr>
<td>lettuce</td>
<td>101</td>
<td>22</td>
<td>9</td>
<td>37</td>
<td>22</td>
<td>8</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>strawberries</td>
<td>70</td>
<td>1</td>
<td>23</td>
<td>7</td>
<td>4</td>
<td>80</td>
<td>51</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Sub total: 1967, 344, 355, 234, 257, 330, 449

*For a list of all crops included, see Appendix C.
**Illness data were listed for "ornamentals." Pesticide use was reported for nursery and greenhouse products combined, but not separately for ornamentals.
***Illness data were listed for "alfalfa." Pesticide use was reported for "hay" of which alfalfa is a subset.


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**Figure 2.1. Activity or Type of Exposure While Poisoned, 1991–1996**

Five activities account for 91.1% of all reported agriculture-related pesticide poisonings.

Source: California DPR 1999

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The profile of activities/type of exposure associated with poisoning incidents varies from crop to crop. Significant variation from the general pattern is found for almonds and strawberries, where ground application of pesticides accounted for 44% and 23%, respectively, of reported poisonings. In addition, hand application of pesticides caused 35% of poisonings in ornamental crops, and drift into neighboring areas accounted for 32% in oranges and 31% in alfalfa (for more details, see Appendix E).

Our analyses are consistent with findings in other reports indicating that the most severe poisoning cases (as defined by length of disability) resulted from early field reentry and exposure during application of highly toxic pesticides such as organophosphates (Weinbaum et al. 1995). A full analysis of poisoning severity is outside the scope of this report.

**Most Pesticide Poisonings Reported in Kern, Fresno and Monterey Counties**

The greatest number of pesticide poisonings (534) were reported in Kern County, with a
majority of incidents occurring in cotton and grape fields. Fresno and Monterey Counties followed closely, with 515 and 428 reported cases, respectively. The 15 counties with the most reported pesticide-related illnesses between 1991 and 1996 are listed in Table 2.3. In nine of these counties, the majority of reported poisonings had no specific crop listed as a source, severely limiting efforts to target regulatory actions to the most problematic crops. Data from all 48 counties in which pesticide poisonings were reported are listed in Appendix F.

### Acute and Chronic Health Effects of Pesticide Exposure

Pesticide exposure can cause both acute and chronic health effects. Acute effects such as vomiting, nausea, dizziness and headaches, fatigue, drowsiness and skin rashes can sometimes be identified and appropriately treated. Long-term or chronic effects such as cancer, birth defects, reproductive problems, developmental problems and nervous system damage are very difficult to link definitively to pesticide exposure since they develop long after exposure and may result from accumulated exposures to a number of environmental or workplace contaminants over many years.

The California pesticide illness reporting system addresses only acute effects. Chronic effects are not accounted for, despite evidence that farm work is associated with elevated risk of several chronic effects (see "Chronic Effects of Pesticide Exposure") (Stubbs et al. 1984, Zahn et al. 1997).

### Acute Effects of Pesticide Poisoning

Acute effects of pesticide poisoning most commonly reported to DPR were skin rashes (23%), systemic symptoms (20%) and eye damage (16%). Systemic symptoms included vomiting, dizziness, and headaches. Eye damage ranged from irritation to permanent damage. Respiratory illness was the sole symptom in only 4% of reported cases, but occurred with other symptoms in 19% of incidents (Figure 2.2). Single symptoms were reported in 63% of the cases. The remaining cases had multiple symptoms.

Not surprisingly, mild to moderate pesticide poisoning may easily be misdiagnosed as stomach-flu, bronchitis or asthma. Even severe pesticide poisoning is frequently misdiagnosed.

<table>
<thead>
<tr>
<th>County</th>
<th>Total Cases Reported</th>
<th>Main Crop(s)</th>
<th>Percent of Cases by Crop*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern</td>
<td>534</td>
<td>Cotton</td>
<td>44.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grapes</td>
<td>22.7</td>
</tr>
<tr>
<td>Fresno</td>
<td>515</td>
<td>No crop listed**</td>
<td>30.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grapes</td>
<td>26.4</td>
</tr>
<tr>
<td>Monterey</td>
<td>428</td>
<td>Broccoli</td>
<td>35.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No crop listed</td>
<td>18.5</td>
</tr>
<tr>
<td>Tulare</td>
<td>399</td>
<td>Oranges</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No crop listed</td>
<td>22.1</td>
</tr>
<tr>
<td>San Joaquin</td>
<td>200</td>
<td>No crop listed</td>
<td>58.5</td>
</tr>
<tr>
<td>Santa Barbara</td>
<td>180</td>
<td>Broccoli</td>
<td>67.2</td>
</tr>
<tr>
<td>Kings</td>
<td>167</td>
<td>Cotton</td>
<td>54.5</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>138</td>
<td>No crop listed</td>
<td>51.4</td>
</tr>
<tr>
<td>Imperial</td>
<td>128</td>
<td>Broccoli</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alletsa</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Watermelon</td>
<td>15.6</td>
</tr>
<tr>
<td>Merced</td>
<td>127</td>
<td>No crop listed</td>
<td>51.2</td>
</tr>
<tr>
<td>Ventura</td>
<td>119</td>
<td>No crop listed</td>
<td>35.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Celery</td>
<td>19.3</td>
</tr>
<tr>
<td>San Diego</td>
<td>114</td>
<td>No crop listed</td>
<td>23.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ornamentals</td>
<td>14.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flowers***</td>
<td>14.9</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>84</td>
<td>No crop listed</td>
<td>58.3</td>
</tr>
<tr>
<td>Madera</td>
<td>79</td>
<td>Grapes</td>
<td>45.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Almonds/Cotton</td>
<td>22.8</td>
</tr>
<tr>
<td>Riverside</td>
<td>77</td>
<td>Grapes</td>
<td>58.4</td>
</tr>
</tbody>
</table>

*Crop categories listed together for each county account for at least 50% of total poisoning cases in that county.

**When no crop was identified in the DPR data, the term "no crop listed" is used.

***Different flowers are grouped here and are listed, along with all other crops, in Appendix C.

*Source: California DPR 1999.

In one review of the medical records of 80 severely pesticide-poisoned infants and children transferred to a major medical center from other hospitals, 16 of the 80 had been
When pesticide poisonings are recognized, it is often difficult to determine conclusively which pesticide or pesticides are responsible. In many cases, more than one pesticide may be used at a time and "inert" ingredients may be responsible for some or all of the observed symptoms. In addition, there are very few inexpensive and commonly available tests to identify the specific pesticide or type of pesticide implicated in a particular poisoning case.

Despite these limitations in available information, researchers have documented the types of pesticides most commonly associated with pesticide poisonings. Organophosphate pesticides (such as oxydemeton-methyl, methyl parathion and methamidophos) are responsible for most of the occupational deaths and poisonings in the U.S. and throughout the world (Blondell and Doboz 1997, Keifer and Mahurin 1997, Moses et al. 1993, Savage et al. 1988). Organophosphates exert their toxic effects by blocking the body's production of acetylcholinesterase (cholinesterase), an enzyme essential to proper functioning of the nervous system. Symptoms of poisoning by organophosphates and n-methyl carbamates, which also inhibit cholinesterase, include blurred vision, salivation, diarrhea, nausea, vomiting, wheezing, and sometimes seizure, coma and death.

Other major pesticide groups include:

- organochlorines such as endosulfan and DDT (banned in the U.S. in 1972);
- phenoxy and bipyridyl herbicides such as 2,4-D and paraquat (still in use in California), and
- fumigants, such as the highly toxic nerve gas methyl bromide.

Organochlorine pesticides can cause anxiety, tremors, hyperexcitability, and seizures potentially leading to death. A wide range of abnormalities in liver function have been reported in exposed individuals as well (Moses 1992).

Phenoxy herbicides exhibit relatively low toxicity for mammals. However, they can be contaminated with highly toxic dioxins, cause serious dermatitis and may cause birth defects, cancer and damage to the immune system (Costa 1997). Paraquat, a bipyridyl herbicide, is highly toxic and widely used throughout the world. It is a powerful irritant, and acute poisoning can damage the liver, kidney and heart and cause irreversible and progressive damage to the lungs, possibly leading to death. In California, paraquat is frequently applied in backpack sprayers, despite the potentially severe consequences of accidental exposure with this application method. There is no antidote to paraquat poisoning (Moses 1992).

Fumigants such as methyl bromide, 1,3 dichloropropene (Telone) and metam sodium are highly toxic and acutely hazardous to workers. Because they are gases, they are readily absorbed through the lungs, from which they spread rapidly throughout the body, severely affecting the central nervous system, lungs, liver and kidneys. There are no antidotes to fumigant poisoning (Moses 1998).

**Figure 2.2. Acute Poisoning Symptoms, 1991-1996**
All agriculture-related pesticide poisoning symptoms are described as skin, system, eye or respiratory effects alone or in various combinations.

Source: California DPR 1998.
Chronic Effects of Pesticide Exposure

While it is difficult to accurately diagnose acute effects of pesticide poisoning, diagnosis is extremely difficult with chronic or long-term effects. Chronic pesticide-related diseases may not develop until 15 or 30 years after exposure. The inherent difficulty in studying such diseases is exacerbated in migrant farmworker populations, which routinely move from state to state or even country to country.

These barriers mean that despite the fact that millions of farmworkers are exposed over extended periods of time to multiple pesticides, few studies have addressed the relationship between exposure and subsequent illness in this population (Levine et al. 1990). In 1993 the federal government conducted a nationwide analysis of all federal and state pesticide health monitoring systems, with a focus on farm-related exposures. Except for a few research studies, monitoring systems only included acute illnesses: none addressed delayed-onset or chronic effects. At the time of the study, only 25 states had laws or regulations requiring any pesticide illness reporting and only California had categories specific to illness associated with occupational exposure to pesticides on farms (U.S. GAQ 1993).

Although very limited data are available, studies which have been conducted show disturbing evidence of chronic effects of pesticide exposure among farmworkers. The following is a brief summary of some of these findings:

Cancer: One cancer study conducted in 1993 found that when compared to the general population, both farmers and farmworkers have increases in multiple myeloma and cancers of the stomach, prostate and testes. In addition, farmworkers show unique increases in cancers of the mouth, pharynx, lungs and liver (Zahm and Blair 1993). The study also suggested that the true risk of elevated cancer among farmworkers may actually be higher, since farmworkers also experience higher death rates due to accidents and other diseases.

Birth defects and stillbirths: Although increased numbers of birth defects have been recorded among farm area residents (Garry et al. 1996), very few studies have looked at birth defects among farmworkers. In one study of 990 single births in Imperial County, limb reduction defects occurred among offspring of agricultural workers three to 14 times more frequently than among the general U.S. population (Schwartz et al. 1986). The risk was greatest for mothers residing in counties with high agricultural productivity (2.4 times) and high pesticide use (3.1 times). In another study, occupational exposure to pesticides during the first and second trimesters increased the risk of stillbirths and early neonatal deaths by 5.5 and 4.8 times, respectively, compared to unexposed groups (Pastore et al. 1995).

Developmental effects: Many pesticides are known to disrupt the human endocrine system. The endocrine system is a complex array of glands, organs and tissues that secrete hormones (chemicals produced by the body) into the bloodstream and regulate a range of
physiological and neurological systems. Reproductive organs appear to be at particular risk for developmental abnormalities when pregnant women are exposed to endocrine-disrupting chemicals. In both sexes the brain, skeleton, thyroid, liver, kidney and immune system are also potential targets for endocrine-disrupting chemicals (Colborn et al. 1993). Since endocrine-disrupting chemicals persist in body fat, they may also exert their effects long after exposure.

Even with limited data available for both acute and chronic effects, a startling picture emerges of the dangers facing the thousands of farmworkers working in California’s agricultural fields. In the following sections, we explore in more depth the barriers farmworkers face in coping with and documenting pesticide poisonings, as well as the limitations in the enforcement systems designed to protect them.
Many Pesticide Poisonings Are Not Reported

Jaime has worked for a strawberry grower for several years. In 1996, his hand was blistered by a pesticide. He went to his doctor for treatment and was told to get a list of all the pesticides used in the fields where he worked. His supervisor refused his request and told him pesticides could not have caused the burn. Jaime returned to work.

“My hand was covered with oozing blisters. I worked until noon, and when I took off my gloves to eat, the glove for my right hand was full of liquid and a lot of skin had come off. It made me nauseous; I couldn’t eat and I decided to leave. I wanted to get Workers’ Compensation but the company didn’t agree. They did not believe me and they said that I should have gone to the company doctor. My supervisor also said that he wanted to see a blood sample. The dermatologist said that [blood work] had nothing to do with it because it was an external injury. I felt that the supervisor was just trying to threaten me.

“Finally, in order to get Workers’ Compensation I had to go to the company doctor. The company doctor told me that I should have gone to him earlier and that I was only trying to take advantage of the company. I told him that I did not like the service there and that I had only come because the company had sent me. He did not believe me and insisted that I was only trying to take advantage of the company. Finally, after many problems, I was able to get Workers’ Compensation, which I had deserved since the beginning.”

Jaime’s experience was better than most; he eventually succeeded in obtaining Workers’ Compensation. Many farmworkers injured by pesticides never see a doctor or receive Workers’ Compensation for their injury. The few analyses available indicate that nationwide, the majority of pesticide poisoning cases are never diagnosed or reported (Blondell 1996, U.S. GAO 1993).18

This chapter highlights the experiences of farmworkers whose pesticide poisonings go unreported and in many cases untreated. We examine various barriers to treatment and reporting of pesticide injuries and illnesses, including limited access to medical care, lack of information and training, employer intimidation and limited training of physicians regarding diagnosis and reporting of pesticide poisonings.

We then highlight some of the policy impacts of underreporting, including lack of attention to farmworker occupational health and safety, chronically underfunded medical services for the farmworker community and continued reliance on dangerous pesticides throughout the agricultural industry. More accurate reporting of poisonings would provide state officials, regulators and the public with a much clearer understanding of the full scope of the pesticide problem among farmworkers and more impetus to move toward solutions.

Most Farmworkers Lack Health Insurance and Access to Medical Care

The National Agricultural Workers Survey estimates that a majority of the 600,000 California farmworkers and their families have no health insurance of any kind—either individual or employer-provided (Rosenburg et al. 1998). Some uninsured farmworkers can seek treatment at federally funded migrant health clinics, but far too many simply go without treatment. Recent immigrants, now ineligible for Medicaid as a result of recent “Welfare Reform,” are now even less likely to seek medical treatment for work-related injuries.

Most farmworkers have limited access to routine medical screening and preventive care. A small minority who mix, load or apply pesti-
Most farmworkers do not know the names of the chemicals being used in the fields where they work. While growers are required to train workers regarding the general risks and symptoms of poisoning, agricultural laborers are not covered by the Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard, which requires employers to inform workers of the risks associated with each chemical in the workplace (OSHA, 1983).

Unfortunately, many farmworkers never receive even the minimal training required, let alone the level of information provided by law to workers in non-agricultural workplaces who may be exposed to toxic chemicals. During the course of several routine inspections in California's Central Coast, county officials noted that individual pesticide applicators and sometimes whole crews of strawberry workers and their supervisors had not received training regarding the symptoms of pesticide exposure.22,23 Dozens of county inspections revealed that farms lacked the mandatory postings and written warnings regarding the risks of pesticide exposure (Appendix G).

As noted above, this lack of information can mean that sickened workers are not adequately diagnosed or treated, even if they do seek medical treatment. It can also mean that workers are deprived of their legal rights under California's Proposition 65. This 1986 law requires that workers potentially exposed to chemicals known to cause cancer and/or reproductive harm must be informed of such dangers. Many farmworkers never receive such a warning.

Grower Intimidation and Interference Silence Many Workers

The primary reason farmworkers are unlikely to report pesticide-related injuries and illnesses is fear of employer retaliation. For example:

- When Magdalena fell ill during her work as a picker at a large strawberry farm in Watsonville, California, she told her foreman that she believed her nausea and vom-
Growers Discourage Injury Reporting

Increasingly, growers implement "incentive programs" that serve as a disincentive for injured workers to report accidents or work-related illnesses. The programs offer a barbecue or small bonus to a crew of 30 to 60 workers if no individual in the crew reports an injury. In this way, employers use peer pressure to discourage reporting and disingenuously portray these programs as "health and safety" programs.

response was that they must have eaten bad meat the night before. He offered milk and Maalox to soothe their stomachs. Only after several workers stumbled out of the field, some of them projectile vomiting, did the foreman and labor contractor send them to a clinic. Even then, many of the workers, disoriented and sickened by the toxic pesticide, had to drive themselves several miles to the clinic before they were decontaminated and treated.

• In Monterey County, an agricultural inspector met with a worker who had an initial complaint of rashes and blistering hands which he believed to be a result of pesticide exposure in the strawberry field where he worked. The inspector met with the injured worker and several others in a secluded spot where the workers told him that they feared their employer would shoot them for blowing the whistle on him. They continued to detail a wide variety of problems ranging from pesticide exposure to minimum wage violations, months of unpaid work and physical threats from their employer.

Retaliation against injured workers is illegal but all too common, and can have a chilling effect on an entire workforce.

Worker complaints of chemical smells in the air, headaches, itching skin and nausea are often ignored and sometimes belittled by employers. Some are told that they must have the flu, others that they must "be hungover" or have "eaten bad tacos." The examples below provide additional evidence of the type of ridicule and intimidation farmworkers often face from employers:

• After 32 workers were poisoned by a potent nerve toxin, carbofuran, in a cotton field near Fresno, their foreman's initial re-

iting were a result of pesticide exposure. She was grudgingly given permission to go to the company doctor, with a warning that she would have to pay for the visit herself if the doctor didn't declare her illness to be pesticide-related. Within days, she was fired.

• When Carla and several other co-workers smelled chemicals in the air, many of them felt nauseous. Carla doubled over and vomited in the field, retching even after her stomach was empty. She was brought to the office and questioned. Her husband, also a strawberry worker, had to leave the field and drive her to the clinic. After a couple of days of bed rest, Carla returned to work. The company management did not speak to her or ask how she felt. At the end of the season, she was not recalled to work for the company, and they refused to give her job back for two years.

The experiences of Magdalena and Carla are not uncommon, and most farmworkers are aware of such cases. Some workers who ask to see a doctor are told that if they are found to be in any way fraudulent in their claim, they will be prosecuted for up to $50,000 under Workers' Compensation fraud provisions. Threats and retaliation keep a blanket of silence around work conditions that can include not only pesticide exposure, but pay scales well below minimum wage, sexual harassment and even threat of physical harm if workers blow the whistle on their employer. If workers are undocumented, their immigration status further silences them due to fear of deportation.

Worker complaints of chemical smells in the air, headaches, itching skin and nausea are often ignored and sometimes belittled by employers. Some are told that they must have the flu, others that they must "be hungover" or have "eaten bad tacos." The examples below provide additional evidence of the type of ridicule and intimidation farmworkers often face from employers:

• After 32 workers were poisoned by a potent nerve toxin, carbofuran, in a cotton field near Fresno, their foreman's initial re-
**Doctors and Clinics Need to Improve Reporting**

Many doctors are unaware that they are required to report any illness suspected of being related to pesticide exposure, even when definitive diagnosis is not possible. Pesticide illnesses can be extremely difficult to diagnose. Many symptoms are systemic, and resemble those of the flu. In addition, the sheer number of chemicals potentially involved in a given incident can be staggering. Accurate diagnosis is further hampered by the fact that many workers have not been trained or provided with adequate information about the chemicals they may have been exposed to in the fields.

The effectiveness of DPR’s Pesticide Illness Surveillance Program depends heavily on accurate and timely reporting by doctors of suspected pesticide poisonings. Yet doctors who frequently treat farmworkers report that they are over-burdened with enormous case loads, and either lack time to fill out paperwork for pesticide reporting or are simply unaware of the state’s reporting requirements. OSHA has had authority to fine doctors for failure to report pesticide illness for years but has failed to do so. Recent regulatory changes allow the California Medical Board to cite and fine physicians for failing to report specific diseases, including suspected pesticide illnesses. 25

The requirement to report, however, does not make reporting a reality. Many cases are identified through reviews of Workers’ Compensation reports, rather than being directed reported to the county health department or agricultural commissioner. When weeks pass before a county learns of an incident, it can be extremely difficult for a thorough investigation to take place, and the incident is likely to be considered only “possibly” related to pesticides.

**Policy Impacts of Underreporting**

Close to 4,000 agricultural poisoning cases were documented in California between 1991 and 1996 (and an as yet untallied number since then). Federal and state agencies acknowledge that documented poisoning statistics greatly underestimate the size and scope of the problem, and ignore the chronic health impacts of pesticide exposure (Pease et al. 1993, U.S. GAO 1993). This underestimation perpetuates problems of inadequate farmworker medical services, lack of attention to farmworker health and safety, and continued reliance on dangerous pesticides in California agriculture.

Medical services available to farmworkers are limited and suffer from chronic underfunding. Federally-funded migrant clinics are only able to treat a small portion of the hundreds of thousands of farmworkers and their families who are uninsured in California. Many workers rely on emergency room services or simply go without medical care. Possible poisoning victims are untreated and incidents are unreported when farmworkers have no access to health care in areas chronically short of physicians and hospitals (Slesinger 1992). Farmworkers, who are known to suffer high injury and death rates as a result of their work, clearly need additional resources for medical services from state and local governments as well as their employers.

Scant attention to farmworker health issues reflects little political will to protect farmworkers from on-the-job hazards, including pesticide exposure. Farm work is consistently ranked among the top three most hazardous occupations in the U.S., and farmworkers suffer the highest rate of chemical-related occupational illness of all job categories in the country (Bureau of Labor Statistics 1987). Yet other hazardous industries have received much more attention from OSHA. Since its creation, OSHA standards, regulation and enforcement have brought about significant decreases in injuries in manufacturing and construction. For ex-

Direct comparison between the federal government’s response to mining versus agricultural health problems reveals particularly stark inequalities. Agriculture and mining are the two most hazardous industries in the country. Yet on a per worker basis, the federal budget for occupational safety in 1985 was estimated to be $4.34 per worker for all industries, $181 per mine worker and only 30 cents per agricultural worker (Schenker 1991).

The continued increase of pesticide use in California is another reflection of the lack of concern at the policy level regarding farmworker exposure to pesticides. Farmworker poisonings result from routine, legal agricultural applications of pesticides, as well as violations of regulatory protections. Economically viable non-chemical alternatives exist and are in use on many crops throughout the state, particularly in the burgeoning organic production sector. Information about many of these alternatives, however, is not widely available to growers, who rely heavily on information provided by private pest control advisors. Recognition of the full scope of farmworker poisonings would contribute to the urgency of promoting safer and sustainable alternatives.

Farmworkers often fall through cracks in the system. Many workers have learned from painful experience that politically and economically powerful agribusiness interests often outweigh farmworkers’ rights in setting regulatory and enforcement priorities. As a result, significant health needs of the farmworker community remain largely unmet, and pesticide poisonings continue.
4 Enforcement of Pesticide Laws Is Weak and Uneven

**Inspection Finding:** Paraquat (extremely toxic herbicide) being used without waterproof apron, face shield or closed loading system. Worker wearing sandals. No training or supervision. No soap for washing. No current use permit or Notice of Intent. Grower told inspector that "applicant jumped the gun."

**Consequence:** Told to comply with the law—no monetary fine.

-Santa Cruz County 4/6/98

Farmworker experience shows that even applications which follow the letter of the law can result in exposure or illness. Thousands of farmworkers are legally exposed to pesticide residues every year in California’s agricultural fields. The risk of poisoning is even higher, however, when laws designed to protect workers from pesticide exposure are not effectively enforced.

On its face, California’s system for enforcing pesticide laws is impressive. Agricultural commissioners’ offices in 55 of 58 counties have a duty to conduct numerous annual “spot check” inspections of pesticide use practices and records and to investigate episodes of suspected pesticide poisoning or misuse. Investigations are triggered when pesticide illness reports are filed with the county or when a worker or other individual files a complaint with the agricultural commissioner about pesticide misuse. The Santa Cruz County inspection outcome above, however, provides a sobering example of the system’s shortcomings.

A few counties do conduct fairly thorough inspections and investigations and issue fines for violations quite regularly. Unfortunately, these counties are the exception rather than the rule, and they are generally counties with less intensive use of pesticides. Inherent conflicts of interest, inadequate training of inspectors, a practice of not issuing fines for most violations and a low fine structure all contribute to weak enforcement of pesticide laws.

**Commissioners Avoid Issuing Fines**

County agricultural commissioners’ jobs include the sometimes conflicting duties of promoting prosperity of conventional agriculture and enforcing pesticide safety laws. In each county, the elected Board of Supervisors approves the appointment of the agricultural commissioner. This political situation exacerbates the conflict for commissioners in counties where agricultural interests have considerable political power.

Inspections of farms and pest control operations are also often less than thorough because, unlike OSHA inspectors, agricultural inspectors have no special training in industrial hygiene (identification, assessment and control of work hazards). Many inspectors do not speak Spanish, rendering questioning of farmworkers during routine inspections impossible and delaying interviews during poisoning investigations.

Agricultural commissioners issue fines for only about one-tenth of the violations they document. In FY 1996/97, only 657 civil penalties (fines) and 184 orders to immediately “Cease and Desist” unsafe pesticide use were issued statewide for pesticide violations (Figure 4.1). The vast majority of actions (5,153) were “Notices of Violation” and “Letters of Warning,” which carry no fine and are not recorded in permanent statewide records. This means that for more than 85% of the documented violations for this period, no central record exists of the nature of violation or the names of businesses receiving…

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No county in the Central Valley, the state’s agricultural heartland, issued more than an average 25 fines per year.
warning notices. As will be detailed below, hundreds of additional violations result in no action whatsoever.

**Fines for Violations Are Low**

Serious pesticide violations are defined as violations "creating an actual health or environmental hazard" or repeat violations "posing a reasonably possible health or environmental hazard." The required fine ranges from $401 to $1,000, as specified by state regulation. Higher penalties are possible if cases are referred for criminal prosecution, but this almost never occurs (averaging less than one case per year statewide). Fines for moderate violations, which "pose a reasonable possibility of creating a health or environmental hazard" or are repeat record-keeping violations, range from $151 to $400. Fines for minor violations which pose no health or environmental hazard may be less than $151.

From 1991 to 1997, almost half of all fines issued statewide were less than $151, and less than 5% exceeded $1,000 (Figure 4.2 and Appendix H). The few large fines issued typically resulted from investigations of pesticide drift or early field reentry affecting large crews of workers. This approach is analogous to the highway patrol issuing speeding tickets only when a huge pile-up occurs, and just sending a letter that says, "Please don't speed" to other violators.

By comparing the five counties issuing the greatest number of fines to the five counties which reported the most agricultural pesticide use for 1995, it is evident that counties with greater agricultural pesticide use and more cases of agricultural pesticide illness issue very few fines (Table 4.1). These include four Central Valley counties where leading labor-intensive crops include grapes and citrus, and Monterey County, a leading producer of lettuce, broccoli, and strawberries, crops also harvested by hand.

No county in the Central Valley, the state's agricultural heartland, issued more than an average 25 fines per year. Fresno County, for example, approved 7,857 permits for restricted pesticide use in FY 1995/96 and re-
Table 4.1  Top Five Counties for Agricultural Pesticide Fines vs. Top Five Counties for Pesticide Use

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* Annual averages of number and dollar value of fines from FY 1991/92 to 1996/97.
** "Pesticide use" is agricultural pesticides, listed in thousands of pounds of active ingredients (Liebman 1997).

Source: California DPR 1998a, 1997a.

Reported 99 cases of pesticide illnesses. Yet this county assessed an annual average of only 19 fines for pesticide safety violations in FY 1991/92-1996/97. In contrast, primarily urban Los Angeles County approved only 474 permits and issued an average of 124 fines annually. (See Appendix I for the enforcement record of all counties.) For FY 1996/97 (most recent data available) the Central Valley counties of San Joaquin and Stanislaus assessed no fines. Both are among the top ten counties for agricultural pesticide poisoning (Table 2.3).

Pesticide Handlers Are Unprotected, Fieldworker Safety Is Neglected

Between FY 1991/92 and FY 1995/96, a total of 2,781 pesticide handler safety violations led to fines, indicating that handlers were not receiving legally required protection. During the same period, only 216 fieldworker pesticide safety violations led to fines (Table 4.2).

Pesticide Handlers Are Not Receiving Proper Protection

Workers who mix, load and apply pesticides ("pesticide handlers") are at the highest risk of death or severe acute poisoning because they handle concentrated pesticide formulations. The cornerstones of pesticide handler safety regulations are requirements for training, use of protective gear and clothing to reduce exposure, and provision of washing facilities to clean up after exposure. The profile of violations resulting in fines reveals that protective gear and training are frequently lacking. Failure to use, provide or maintain protective equipment for pesticide handlers was cited 1,155 times between 1991 and 1996.28 (For details see Appendix G.)

Frequent failure to provide and maintain protective gear and closed systems is alarming...
and inexcusable. It is not, however, surprising to find that citations for failure to wear the gear are common. Protective gear, such as gloves, coveralls and respirators, is uncomfortable and unbearably hot in summer weather and can be cumbersome and slow down work. Because of these limitations, occupational health and safety experts consider personal protective gear the least desirable form of protection (Soule 1991). Emphasis must be shifted to eliminating use of the most toxic pesticides and providing engineering controls, such as enclosed tractor cabs with air filters.

Inadequate pesticide handler safety training was involved in 536 fines during the five-year period. Inadequate emergency medical care provisions for pesticide handlers played a part in 247 fines. A 1992 Monterey County poisoning case illustrates the perils of delayed emergency treatment and inadequate training:

A 22 year-old pesticide applicator splashed the extremely toxic insecticide Phosdrin on himself when handling an improperly closed container. He was directed to shower and then go back to work applying Phosdrin throughout his shift. He began to feel ill but worked the full shift because he was afraid of reprimand. On the way home from work he drove to the doctor. His blood cholinesterase was found to be depressed 75% below baseline, the level needed for proper nervous system function. He was hospitalized and treated. It took over two months for his cholinesterase to return to baseline levels.

**Fieldworker Safety Is Neglected**

Current fieldworker pesticide safety regulations are designed to protect fieldworkers by prohibiting work in fields immediately following pesticide application and during restricted entry intervals (REIs). Provision of wash-water, soap and towels in fields is also required, as is posting of general information about pesticides. These regulations have major weaknesses. The U.S. EPA acknowledges that most REIs are set to prevent acute poisoning, but are not designed to protect workers from chronic health effects (U.S. EPA 1992). Workers are supposed to be directed to bathe and change to clean clothes at the end of each workday. However, they often lack adequate access to showers, extra clothes and laundry facilities to follow this advice. Workers do not know which fields to stay out of because posting is only required if the REI is eight days or greater or if posting is required on the label. Otherwise only oral warnings, notoriously unreliable and impossible to trace, are required.

From FY 1991/92 to 1995/96 only 216 violations of farmworker pesticide protections, such as REI violations, failure to provide wash-water, and failure to post treated fields, resulted in fines. Unfortunately, the small number of fines related to fieldworker safety violations does not mean all is well. Over this same time period agricultural commissioners conducted 15,028 fieldworker inspections statewide and noted 2,888 safety violations or "non-compliances."

This disturbing record of neglect of hazards to fieldworkers must be reversed. Appropriately targeted, thorough fieldworker safety inspections with fines levied for violations could have a significant impact in documenting these violations and promoting better protection of fieldworkers.
When No Violation is Found, Worker Illnesses Are Ignored

County inspectors are in the best position to monitor how well laws are protecting workers. However, in the two episodes highlighted below, workers clearly became ill but the cases were closed without further follow-up because no specific violations were found:

"I started working in this field about 9:30, moving pipe... when I started to get a headache and feel nauseous. By the time I finished the row, the symptoms were strong. I could smell an odor in the field. The supervisor took me to urgent care.... No blood sample was taken until the next day."

Report Conclusion: The restricted entry interval for Metasystox R expired at 2:30 am. The irrigator entered the field about 7 hours later and his illness complaint was handled correctly by the supervisor. No regulations were violated, and no action will be taken at this time.

—Santa Barbara Investigation 10/21/98
(Santa Barbara Episode #1998-994)

[A worker] was spraying the end of the strawberry field.... The wind was blowing five to seven mph south to north. This was the direction he was traveling when pesticide got in his eyes around the goggles he was wearing.... Later he was experiencing pain and itching around both eyes.

Report Conclusion: Because label requirements were followed for personal protective equipment and the application method was done in a suitable manner, no violation (enforcement action) is recommended.

—Monterey Investigation 6/6/97

A Closer Look at Worker Safety Violations: County Case Studies

A sample of pesticide exposure investigation reports and pesticide use inspection records for 1995-1998 was collected from the top strawberry producing Central Coast counties of Monterey, Santa Barbara, Santa Cruz and Ventura to get a closer look at the types of violations found and actions taken. This summary is limited to worker safety violations and does not include use reporting or other record-keeping violations.

Information on these specific inspections was requested because strawberry production is both pesticide and labor intensive. In the strawberry industry growers use as many as 148 different pesticides in various formulations, often in combinations of up to four pesticides. Strawberries are the most chemical intensive crop in the state of California (Liebman 1997) and also one of the most labor intensive, with a harvest season that extends for eight to nine months of the year. For every strawberry worker, an estimated 200 pounds of pesticides are applied.30

This review of county records reveals a disturbing pattern of failure to issue fines for violations that create a clear risk of injury or illness (see Appendix) for full summary of findings:

• Failure to provide wash-water, soap and towels for fieldworkers resulted in a Notice of Violation in only 28 instances and a minimal $151 fine in three instances. In contrast, field sanitation regulations require CalOSHA inspectors to assess a minimum $750 fine for inadequate handwashing facilities for fieldworkers.31

• In 75 instances, failure to provide adequate protective gear for pesticide handling resulted in no action or only a Notice of Violation.

• Fines were rarely assessed for repeat violations uncovered in repeat inspections of a single employer’s farm or spray operations.

Monterey County

Review of 192 pesticide field inspections conducted in Monterey County between 1995 and 1998 show that numerous violations with clear potential to cause illness resulted in no fine (Table 4.3). These included 40 violations of protective gear requirements; 11 instances of failure to provide washing facilities for fieldworkers; ten violations of Monterey County’s field posting ordinance, which requires posting in fields after application of any pesticide with a reentry interval of at least 24 hours; four violations of statewide posting requirements; and five instances of use of equipment unsafe to operate.

Sixteen pesticide episode investigations conducted between 1996 and 1998 were reviewed. Fines were assessed as a result of five of these investigations. While four fines were in the serious range, they seem very low given the extent of worker illness and risk of illness in each case:
### Table 4.3. Monterey County Summary

<table>
<thead>
<tr>
<th>Type of Violation or Hazard</th>
<th>No Notice/Action</th>
<th>Warning</th>
<th>Fine*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide solution draining down road towards workers</td>
<td>$300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No soap for mixer/loader/applicators</td>
<td>$300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of high toxicity organophosphate above legal rate without protective gear</td>
<td>$500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew allowed into posted field became ill</td>
<td>$2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew working in posted field but no illness</td>
<td>$200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spraying within 500 ft. of road during school bus hours</td>
<td>$150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment in poor repair caused exposure and illness</td>
<td>$600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticides transported in van with workers</td>
<td>1</td>
<td>2</td>
<td>$800</td>
</tr>
<tr>
<td>No emergency medical care plan</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>No washing facilities for applicators</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Monterey County required field posting</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Fieldworker Pesticide Info Sheet A-9 not posted at field</td>
<td>7</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Adequate protective gear not provided</td>
<td>2</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Application equipment not safe to operate</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate respiratory protection program</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Violations of statewide posting requirements</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No washing facilities for fieldworkers</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No application-specific fieldworker training</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Violation of methyl bromide worker buffer zone</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl bromide reentry interval violation</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No applicator training</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field supervisor not trained</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety/training violations for methyl bromide field fumigation</td>
<td></td>
<td></td>
<td>$800</td>
</tr>
<tr>
<td>Methyl bromide buffer zone misrep., worker entry, ripped tarp</td>
<td></td>
<td></td>
<td>$3,000</td>
</tr>
<tr>
<td>Insecticide drift resulting in illness of 12 fieldworkers</td>
<td></td>
<td></td>
<td>$2,000</td>
</tr>
</tbody>
</table>

| Percent of Total | 10% | 84% | 6% |

* Each fine specific to one episode. Fines for record-keeping violations not listed here.

- Drift of diazinon applied by an airblast sprayer in a neighboring apple orchard resulted in illness in 12 strawberry harvesters. The applicator was fined $2,000.

- A grower was fined $800 for not training two individuals who worked as shovelers in a methyl bromide application and directing one worker to enter the fumigated field to repair the tarp without testing the air or providing respiratory protection. An additional $400 fine for allowing a worker to enter the buffer zone while working as a field-guard was overturned on the grounds that the worker may only have spent a brief time in the buffer zone. For the same incident, the fumigation company was also fined $3,000 for misrepresenting the residential buffer zone on the permit, sending employees to repair the tarp without air monitoring or respiratory protection, and allowing the tarp to become damaged.

- A crew of 27 harvesters became ill after working for two hours in a field treated just a day and a half earlier with the organophosphate Metasystox R, which has an REI
of 72 hours. The grower and contractor were each fined $1,000.

- A crew of four was found weeding in a posted field during an REI but the fine was only $200 because “no illnesses resulted.”

- A greenhouse was fined $500 for failure to provide protective gloves and clothing and for use of a highly toxic organophosphate above the allowable label rate, resulting in illness of the applicator.

- A grower was fined $400 for failure to maintain safe equipment after a leaky valve caused applicator exposure and illness.

- As a result of a property loss investigation, compensation of $1,500 was paid for damages from herbicide drift on a strawberry field.33

- The agriculture commissioner’s office was contacted the day a worker first went to a doctor, who removed her from work for a week due to a depressed cholesterol level.34 The commissioner’s office attempted to contact the ill worker at the doctor’s office but for unexplained reasons did not visit the worksite until two weeks later. By that time it was too late to sample plants and the greenhouse floor for organophosphate pesticides. The employer denied using pesticides other than bleach. Sales records were not checked, and the names of household pesticides found in the storage area were not listed in the report.

Santa Barbara County
Half of the 18 Santa Barbara pesticide exposure investigations reviewed had unexplained delays in physician reporting to the agricultural commissioner, delays in commissioner initiation of investigation, or both.35 Delays can seriously compromise investigations because pesticide residues degrade and memories fade.

Treatment of fumigant drift incidents was inconsistent. One October 1996 investigation, triggered by a neighbor’s complaint about a methyl bromide field fumigation, resulted in a $450 fine for drift violation of the buffer zone and holes in the fumigation tarp. In contrast, a similar complaint about illness from drift of the fumigant metam sodium resulted in only a “Letter of Warning,” even though permit conditions were clearly violated.

In three investigations, safety violations were clearly documented but no fines or even written violation notices were issued. In two of these instances, repair of contaminated equipment was conducted without proper training or protective gear. In the third, improper use of valves caused organophosphate insecticide to spew onto the handler; the mistake was attributed to “human error” rather than inadequate training and supervision. In one case of potential drift affecting a crew of fieldworkers, no field samples were taken to assess extent of drift.36

One hundred and twelve violation notices and five inspection reports were also reviewed. Santa Barbara County was quite proactive in levying fines for methyl bromide permit condition violations. In three instances of methyl bromide buffer zone violations and eight instances of violation of the county’s specific ambient temperature permit condition, the violators were assessed $300 fines. Fines of $151 were assessed in three instances for failure to provide washing facilities for fieldworkers, but only violation notices were issued in 17 other instances. Fines of $151 were assessed twice for failure to wear protective gear, but no action was taken in four other violations of protective gear requirements.

Santa Cruz County
A review of 93 pesticide use inspection reports for Santa Cruz County for 1997 and 1998 revealed numerous violations with clear potential to cause human illness which resulted in no fine. These included 31 instances of failure to provide adequate protective gear, and ten instances of unsafe use of the highly toxic herbicide paraquat, which is corrosive to skin and eyes and can cause lung damage and even death.

Safety violations in paraquat use included mixing and loading without closed systems.
applying paraquat with backpack sprayers without required protective clothing, lack of washing facilities at the application site, mixing paraquat at twice the legal rate, and not preventing spills from spreading.

Only six violation notices were issued. For the other inspections where violations were found, no action was taken.

Ventura County

Inspection Finding: On February 7, 1996, fieldworkers were harvesting strawberries during a restricted entry interval (REI), an inspector stopped the operation. On February 8, 1996, during the same REI, the farm operator sent the fieldworkers back into the treated field.

Consequence: No enforcement actions were taken (California DPR 1997b).

The Ventura County agricultural commissioner’s office has recently come under public scrutiny for falling short in carrying out its duty to enforce pesticide regulations and for failing to take necessary actions to protect workers and the public from pesticides. The reappointment of Agricultural Commissioner Earl McPhail, who has held his post for 20 years, is currently in jeopardy. Program deficiencies pointed out in DPR Annual Effectiveness Evaluations include multiple instances of failure to issue fines for serious or repeat violations, failure to issue any fines for FY 1995/96, failure to conduct enough inspections, and failure to complete investigations in a timely manner.

The Ventura County agricultural commissioner has had $11,000 of funding (from the pesticide mill tax) withheld by DPR since 1994 due to these serious pesticide enforcement program weaknesses. DPR conducts both annual and semi-annual evaluations of each agricultural commissioner’s office, but rarely takes the action of withholding funding for enforcement program deficiencies. Ventura County inspection records are not presented in this report because they lack sufficient detail.

Conclusion

Striking problems in the state’s regulation and enforcement of pesticide laws were revealed through our examination of statewide pesticide enforcement statistics and a closer look at several counties. When pesticide users are not held accountable for their actions, agricultural workers and the general public are forced to bear the costs of their disregard for safety rules. This longstanding policy of leniency towards pesticide violations also puts law-abiding pest control applicators and growers at a competitive disadvantage.

It is sometimes debated whether enforcement is an effective tool for improving safety. Once again, the highway safety example provides insight: the drop in the number of traffic fatalities since implementation of the mandatory seat-belt law and stiffer penalties for drunken driving indicate that enforcement can indeed be effective. Our recommendations for strengthening California's system of enforcement and reducing the risk of farmworker poisonings are outlined in Chapter 5.
Recommendations: Protecting Farmworkers from Pesticides

"Pesticide exposure can cause serious acute illness among farmworkers. In the incident described in this report, workers entered a field well before the end of a label-specified restricted entry interval (REI) and incurred pesticide exposure that resulted in a moderately severe illness. The incident demonstrates that 1) posted and oral warnings based on the REI are necessary to prevent illness among workers performing hand labor in fields recently treated with pesticides and 2) failure to adhere to an REI can result in substantial morbidity (illness) among exposed workers. Because this incident demonstrates that sole reliance on these control measures may be inadequate, the substitution of safer, less toxic alternative pesticides should be adopted when feasible" (CDC 1999).

As demonstrated in the above excerpt from a recent Center for Disease Control (CDC) report, reliance on notification measures alone is in many cases inadequate to prevent farmworker poisoning by pesticides. Farmworker experiences show that even pesticide applications which follow the letter of the law can result in exposure or illness.

The most important and urgently needed step to reduce exposure is eliminating use of pesticides which endanger the health and well-being of farmworkers throughout the state. Phasing out use of the most dangerous pesticides—those that cause cancer or reproductive harm, or are extremely toxic to the nervous system—would represent tremendous progress toward a more sustainable, healthy and humane agricultural system. Substituting safer alternatives for toxic materials is a well-established first step in worker protection as outlined in the widely accepted principles of industrial hygiene (Soule 1991). Specific steps needed to reach this goal and effectively promote viable alternatives are outlined in Recommendation #1 below.

To reduce the level of farmworker exposure to those pesticides which remain registered, we recommend outdazing several hazardous use practices, improving protection from drift and residue exposure, and significantly strengthening the existing enforcement system. Improved reporting and treatment of pesticide illnesses are also critical, as is access to accurate information on pesticide use, violations and illnesses for both farmworkers and the general public. Below we explore these recommendations in greater detail, including some of the specific steps needed to reduce farmworker exposure to dangerous pesticides.

1. Rapidly phase out use of the most toxic pesticides and promote healthy and sustainable alternatives.
   • California’s Department of Pesticide Regulation (DPR) should develop and implement a plan to phase out use of pesticides that cause cancer or reproductive harm or are highly poisonous acute nerve toxins. In addition, the agency should develop and implement a plan for reducing use of all pesticides, including setting annual goals for total use reduction and ensuring, at the same time, that toxicity is not increased.
   • DPR should immediately prohibit use of pesticides that are most hazardous to workers (highly acute nerve toxins, carcinogens and pesticides that cause reproductive harm) on labor-intensive crops.
   • California Environmental Protection Agency (CalEPA) should commit significant resources to organic agricultural research and programs to assist farmers in pesticide use reduction and in the transition to sustainable alternatives."
CalEPA and California Department of Food and Agriculture (CDFA) should increase their research and training budgets in each of the following areas: organic agriculture, biointensive and integrated pest management programs and pesticide use reduction programs. These expenditures should be analyzed annually and compared with expenditures in support of conventional agriculture. Results of this analysis should be made public and widely available.

2. Improve regulations to reduce farmworker exposure.
   - DPR should ban aerial spraying of agricultural pesticides, and prohibit use of backpack spraying for all restricted use pesticides and acute systemic toxins.
   - DPR should expand posting requirements to apply to all agricultural pesticide applications. Warnings should be required prior to application along the perimeter of all areas where application occurs in such a manner that the warnings are highly visible to workers and other people who might enter the area. All posting signs should include pesticide name and reentry date and be written in the primary language(s) of the farmworkers.
   - DPR should require that employers notify farmworkers 24 hours in advance of all pesticide applications in fields they work in or near.
   - DPR should extend restricted entry intervals (REIs) to take into account multiple pesticide exposure and prevention of chronic health effects. Early reentry exceptions should be eliminated, and DPR should document and make public the scientific basis for REIs.
   - DPR should establish and/or expand worker buffer zones for all fumigants and air-blast spraying.
   - Growers should be required to provide washing and laundry facilities for farmworker use on any farm where pesticides are applied.
   - Training requirements should be improved and enforced for all pesticide applicators and workers who enter fields of handle crops.
   - Agricultural workers should be covered by OSHA’s Hazard Communication Standard.

3. Strengthen enforcement of existing laws.
   - DPR should set minimum mandatory penalties that county agricultural commissioners must issue for violations of pesticide laws that could endanger the health and safety of workers. The option of issuing “Notices of Violations” and “Letters of Warning” should be abolished.
   - DPR should increase fine levels for moderate and serious violations and enforce the automatic “serious” designation for repeat “moderate” violations, as specified in pesticide regulations.
   - DPR should require pesticide users to be familiar with regulatory requirements. The “ignorance excuse,” a policy of leniency towards violators if they claim to be unfamiliar with relevant requirements, should be abolished. (The DPR Pesticide Policy Manual currently recommends issuance of a “Notice of Violation” rather than a fine for a violation that is a possible health and safety hazard if the violator is judged unfamiliar with pesticide regulatory requirements.)
   - An independent review board should be established to annually evaluate the performance of each county agricultural commissioner, with participation from agricultural workers. Elected county officials should receive copies of all agricultural commissioner workplans and evaluations. DPR should exercise its authority to withhold funding from agricultural commissioners’ offices that inadequately enforce regulations.
   - DPR should require that every county agricultural commissioner’s office have at least one bilingual investigator on staff.
• DPR should require special investigations of all pesticide illnesses resulting from legal use practices, rather than allowing agricultural commissioners to take no action in cases where no specific violations are found.

• Poisoning investigations should always involve the Department of Health Services' Occupational Health Branch and/or OSHA, in addition to DPR.

• State agencies should assess stiff penalties for employer retaliation against whistleblowers and for interference with workers' right to organize.

• Agricultural inspectors should enforce existing law (CCR, Title 8, Section 3457), which mandates a minimum $750 fine for inadequate sanitation facilities, as specified in CalOSHA regulations.

• DPR should mandate that egregious violators whose actions endanger workers shall be referred for civil or criminal prosecution and/or have pesticide use permits and licenses revoked for a full growing season.

4. Improve reporting of pesticide poisonings.

• Work “safety incentive” contests that provide bonuses or prizes to work crews when no injuries or illnesses are reported in a given time period should be prohibited.

• Insurance companies should be required to immediately forward copies of “Doctor's First Report of Occupational Illness or Injury” involving pesticides to the Department of Health Services (DHS) and DPR Worker Health and Safety Branch.

• DHS should establish and fund a program to monitor long-term health impacts of pesticide exposure among farmworkers.

• DHS should expand its existing program to train doctors about pesticide poisoning diagnosis, treatment and reporting requirements. Crop-sheets highlighting symptoms of pesticide poisoning should be widely distributed to migrant health clinics and other physicians or health care providers.

• CalOSHA and the Medical Board of California should exercise their authority to fine doctors who fail to report pesticide poisonings promptly to the county health authorities.

5. Improve farmworker access to medical treatment.

• Failure of agricultural employers to provide workers and doctors with full information about chemicals involved in a possible exposure incident should constitute “interfering with access to medical treatment” and should be enforced aggressively. Regulations requiring employers to take exposed workers promptly to a doctor should be enforced.

• The federal government should increase funding for migrant clinics and other health care providers for farmworkers, including funding for free annual physicals to screen for symptoms of pesticide exposure. These free physical exams should be available to all, regardless of immigration status.

• Agricultural employers should be required to provide health insurance and/or establish a fund to finance farmworker health care costs.

• DHS should expand cholinesterase monitoring programs to include all field workers who could be exposed to organophosphates or carbamates during the course of their work.
6. Ensure farmworker and public right-to-know.

- DPR should expand workers' right-to-know to include posting of REIs and descriptions of acute and chronic health effects associated with each chemical. The information should be posted in a neutral location on the farm in an understandable format and language.

- The Office of Environmental Health Hazard Assessment should ensure that all farmworkers are guaranteed "adequate warning" about exposure to carcinogens and reproductive toxins, as required under Proposition 65.

- County agricultural commissioners should document all drift inquiries; monitor, analyze and publish trends in inquiries and complaints; and institute mandatory site visits in response to repeated inquiries and/or complaints.

- County agricultural commissioners should make the results of pesticide investigations available to DHS and the public within three months of an investigation.

- DPR should release pesticide use and illness data no later than six months after the end of the year for which the information is reported, and should produce an analysis of pesticide use trends and reported poisonings.

- DPR should establish a public database with information on the amount of pesticides used, violations reported, number of workers affected by the violations and number of pesticide illnesses for each user/grower. This integrated database could be an expansion of the Agricultural Civil Penalties database of pesticide enforcement actions, and would be analogous to the national Toxin Release Inventory and the statewide Hot Spots database for air polluting chemicals.
Endnotes

1 Farmworker accounts are excerpted from worker testimony and county pesticide episode investigation reports. Names have been omitted or changed to protect the workers.

2 Symptoms of acute pesticide poisoning occur shortly after exposure and are followed by relatively rapid recovery. Acute effects may result from a single exposure to a single substance or from multiple exposures over a short time period.

3 Under state law in 12 states (including California), Workers’ Compensation coverage is the same in agriculture as for all other industries. In 13 states, no Workers’ Compensation coverage is required under state law for farmworkers. In 25 states, coverage is more limited in agriculture than in other industries (U.S. Dept. of Labor 1998).

4 This is clearly illustrated in the disparity among “buffer zones” around farms where the soil fumigant methyl bromide is applied. The buffer zone required for workers in a neighboring field is in some cases less than half that required for residential areas, itself an inadequate distance. Independent monitors have documented levels of methyl bromide drift well above what the state considers “safe” at distances more than ten times the official residential buffer zone (Environmental Working Group 1998).

5 See Appendix A for an overview of research methods.

6 Farmworker testimony collected from staff at the Organización en California de Lecheros Campesinos, Inc. The name has been changed to protect the workers.

7 Ingestion of all these ingredients can thus result in pesticide poisoning. They are added to pesticide formulations to make the pesticide more potent or easier to use. They include solvents, spreaders, wetters, wetting agents, surfactants, and other chemicals (Marklund et al. 1999). At least 572 chemicals on the U.S. EPA list of pesticide inert ingredients are or were once registered as pesticide active ingredients (Knight 1997).

8 California physicians report chronic effects in less than 2% of cases (Dua 1999). This reflects the difficulty of recognizing chronic pesticide-related illness.

9 Nationwide and in California, the organic food industry has grown by more than 20% per year for the past seven years (Lipson 1997).

10 While pesticide use explained only 57% of the variation in number of poisonings among these five crops, the relationship was statistically significant (P = 0.02). Since high volume does not necessarily mean high toxicity and also does not reflect intensity (volume per acre of harvested area), it is not surprising that the relationship is not stronger.

11 Possible explanations for incomplete data include lack of information submitted from the attending physician; and/or lack of information about on-farm pesticide use, exposure during equipment maintenance, or exposure at pest control company facilities.

12 Specifically, early field entry and exposure during application of organophosphate insecticides and mixtures of organophosphate and n-methyl carbamates (cholinesterase inhibiting nerve toxins) were found to cause the most severe poisonings. While some dangerous organophosphates (e.g., methylphos and ethyl parathion) are no longer registered, other nerve poisons (e.g., oxydemeton-methyl, parathion, and methamidophos) are still in heavy use.

13 Since this survey was conducted some other states (e.g., Washington) now monitor farm-related pesticide illnesses.

14 For example, the incidence of pulmonary disorders among farmworkers is three times that of farmers, and pesticide exposure is most likely a contributing factor (Garcia et al. 1996). For farmworkers who live longer, cancers often appear after they have left agricultural work and hence other occupations most likely appear on death certificates (Cahen and Blitz 1993).

15 Hormones are transported throughout the body and function to control virtually every bodily process and to maintain "homeostasis," or balance, among different body systems. Too little or too much hormone can cause a wide range of physiological or neurological problems.

16 The organs most at risk include mammary glands, fallopian tubes, uterus, cervix and vagina in female tissues; and prostate, seminal vesicles, epididymides and testes in male tissues. Endocrine-disruption may exert its negative effects indirectly as well if they impair the immune or nervous systems or cause cancer in endocrine glands (Henderson 1996).

17 Farmworker accounts are excerpted from worker testimony and county pesticide episode investigation reports. Names have been omitted or changed to protect the workers.

18 According to a General Accounting Office report, U.S. EPA has no capability to accurately determine national incidence or prevalence of pesticide illnesses that occur in the farm sector (U.S. GAO 1993).

19 Under the medical surveillance program, applicants are required to have baseline cholinesterase blood tests and periodic blood tests during any period they are working with specified pesticides (Category I and II organophosphates and n-methyl carbamates) more than six days out of 30 (California Code of Regulations, Title 3, Section 1727).

20 Farmworker testimonies were collected and transcribed (from 1996 to 1998) by United Farm Workers of America, AFL-CIO.

21 Ibid.

22 Ibid.

23 This is also reflected in County Agricultural Commissioner Inspection Reports for Monterey and Santa Cruz Counties, 1996-1998.


26 Fines run from $100 to $2,500, and county health officers have the authority to refer non-reporting physicians to the medical board for sanction (California Code of Regulations, Title 8, Section 6728 (Duty to Provide, Maintain and Use Protective Gear)).

27 California Code of Regulations, Title 8, Section 6130.

28 In a majority of cases the violation was cited as a general violation of California Code of Regulations, Title 8, Section 6728 (Duty to Provide, Maintain and Use Protective Gear).

29 Monterey County investigation PER # 92-2046.

30 This figure is based on a pesticide application rate of 302 lbs. per acre and a UF3/2 estimate of 1.5 workers needed to harvest an acre of strawberries.

31 California Code of Regulations, Title 8, Section 3457.

32 CalOSHA has responsibility for worker protection in all industries so it does not have as much enforcement presence in agriculture as the county agricultural commissions.

33 Monterey County Investigation 15-MON-98.

34 From the following Monterey County Investigation Reports, listed in order of description: ACP #6/96-01; ACP #6/96-02; ACP #6/96-006; ACP #6/96-010; ACP #6/96-063; Investigation Report of 2/14/96.

35 Monterey County Investigation ACP-MON-96/99-005.

36 Santa Barbara Investigations with unexplained delays: 38-SB-94-97-32; 98 SMBED 2E; 98-26; 98-26-02; 97-1380; 97-1389; 98-09-04; 97-1139.

37 From the following Santa Barbara County Investigation Reports, listed in order of description: ACP-SB-95-02; ACP-SB-95-01; Episode #95-SMBED 1E; Episode #96-E9; #95-048; Episode #97-1130; Episode #97-1134; Investigation #95-SB-36.

38 For additional information or a list of publications on promising alternatives, contact Pesticide Action Network of California for Pesticide Reform.
References


Department of Health and Human Services. 1996. Migrant health program: an atlas of state programs which estimate number of migrant and seasonal farmworkers and members of their families. Health Care Financing Administration, Washington, D.C.

Dubois, V. and T. Anthony. 1997. Farm workers may soon have more monitoring for pesticide exposure. UC Berkeley Environmental Health Center, San Francisco, CA.


Lipton, M. 1997. Fighting with the "Q" word. Organic Farming Research Foundation. Santa Cruz, CA.


Appendix A

Methods

Ilness Data Analysis
We analyzed California Department of Pesticide Regulation (DPR) illness reporting data from 1991 to 1996 and compared the results with analyses of pesticide use data from 1991 to 1995 (Liebman 1997). At the time of preparation of this report, use data for 1996 were not available to the public.

Ilness data analyzed included all cases identified, after investigation by DPR, as definitely, probably, or possibly related to pesticide exposure and which were listed as agricultural cases, or provided a crop name, or in which pesticide use was intended to contribute to production of agricultural commodities, or in which the affected person worked for a food processing facility (DPR 1999).

Accounts from Workers
Sources of worker accounts included testimony from farmworkers collected and translated by the United Farm Workers (UFW) and excerpts from county pesticide episode investigation reports. Names have been omitted or changed to protect the workers.

Enforcement Data Analysis
Analyses of fines and pesticide use violations were prepared using data from the Agricultural Civil Penalties (ACP) Database for FY 1991/92 to 1996/97. These data are maintained by the California DPR Enforcement Unit. Data from 1990/91 were not used because many penalties (fines) had never been finalized. Six year averages of both the number and total dollar amount of fines levied by individual counties are presented to show each county’s general level of enforcement activity over six recent years. That enforcement activity was compared to the most recent available agriculture-related pesticide illness data (1996), because it is plausible that the level of agricultural pesticide poisoning in a county could be affected by pesticide enforcement activity in preceding years.

The profile of pesticide safety violations resulting in fines addresses only the roughly 10% of all violations documented by agricultural inspectors which resulted in fines and excluded record-keeping violations. This profile utilizes the ACP database for Fiscal Years 1991/1992 to 1995/1996 because 1996/1997 data were received after this more complex analysis was completed. The ACP database sometimes refers to regulation subsections which detail very specific requirements. For example, California Code of Regulations (CCR) Title 3, Section 6738(a)(3) requires employers to “Assure precautions to prevent heat stress during protective gear use are taken.” More often only a general section number, such as 6738: “Provision of protective equipment,” is listed or retrievable. In many cases a single fine involves a number of code and regulation violations. However, the ACP database is not coded to allow analysis of most common groups of regulations violated at the same time.

County Enforcement Data
We collected county agricultural commission reports from 1996 through 1998 which were available to the public under the California Public Records Act. Documents were collected from the following counties: Santa Barbara, Ventura, Santa Cruz and Monterey. Specific documents requested and analyzed included: pesticide use monitoring inspections, field worker safety inspections, pre-application site inspections, notices of violation, notices of proposed action and notices of proposed decision, and pesticide episode incident reports. Use inspections and violations were requested only for strawberry and raspberry farms in order to limit the volume of documents. Incident reports and documents related to Agricultural Civil Penalties (Notices of Proposed Action and Decision) were requested for all agricultural commodities. These original documents were analyzed in the context of statewide data compiled by DPR. Specific investigations of pesticide illness episodes cited in the text are identified by investigation number or date of incident.
## Appendix B

**Reported Use of Toxic Pesticides in California, 1995**

This table is a compilation of data on the toxicology and reported use of pesticides in California in 1995 (the last year for which use data are available). Pesticides were included if they met two criteria: 1) they appear on the indicated official lists of toxic pesticides and 2) they were used in California in 1995. A description of the toxicology and hazard lists is included in the text.

Original source: Liebman (1997). Some figures were updated using corrected data from California DPR (1998b). Endocrine disruptors were also identified by Keith (1997).

### Key to Hazard and Toxicity Lists

A. U.S. EPA “Probable Human Carcinogens”  
B. California’s Proposition 65 Pesticides that Cause Cancer  
C. California’s Proposition 65 Pesticides that Cause Developmental Toxicity  
D. California’s Proposition 65 Pesticides that Cause Female Reproductive Toxicity  
E. California’s Proposition 65 Pesticides that Cause Male Reproductive Toxicity  
F. Endocrine Disrupting Pesticides  
G. U.S. EPA Category I Extremely High Acute Toxicity/Systemic Pesticides Labeled “DANGER/POISON”  
H. U.S. EPA Category II Organophosphate and Carbamate Nerve Toxins  
I. Restricted Use Pesticides. Six pesticides (azatrazine, benoxuxin, bromacil, diuron, prometon, and simazine) are included on this list (potential to pollute ground water) only when used in a designated Pesticide Management Zone, that is, where they already have been detected in groundwater.

### Pesticide active ingredient | Hazard and Toxicity | Pounds of active ingredient
--- | --- | ---
1,2-Dichloropropane | B | 7
1,3-Dichloropropene | A, B, I | 409,821
2,4,5-T | F | 0
2,4-D | F, I | 462,204
3-Chloro-P-toluidine hydrochloride | I | 0
4-Aminopyridine | I | 22
Aflatoxin | A, B | 6
Acrolein | G, I | 363,127
Alachlor | B, F | 41,119
Aldicarb | R, G, I | 358,659
Aluminum phosphide | G, I | 90,968
Amitrole | A, B, F | 1,858

### Pesticide active ingredient | Hazard and Toxicity | Pounds of active ingredient
--- | --- | ---
Arsenic (inorganic) | B, G | 125,055
Azatrazine | F, I | 36,192
Azathoprine-methyl | G, I | 432,248
Bendiocarb | H | 1,526
Benomyl | C, E, F | 196,154
Benzoxazin | I | 655
Bromacil | I | 95,478
Bromoxynil | C | 119,815
Cyclopyldimethylic acid | A, B | 44,431
Cadmium | A, B, F | 0
Captan | A, B | 0
Cape | A, B | 752,677
Carbamyl | E, H, I | 856,687
Carbofuran | G, I | 247,861
Carbon disulfide | C, D, E | 0
Carbon tetrachloride | A, B | 0
Chlordane | A, B, F | 184
Chlordimeform | A, B, F | 23
Chloroform | G | 11
Chloroprene | G, I | 2,798,239
Chlorothalonil | A, B | 1,130,282
Chlorpyrifos | H | 3,443,184
Chromium (chromic acid) | B, G | 117,092
Creosote | A, B | 444,461
Cyanazine | C | 646,409
Cyhalothrin | C | 0
Cyhexatin | C | 0
Cypermethrin | F | 98,827
Daminemid | A, B | 7,868
DDVP | B, G | 6,159
DEF | G | 885,595
Diazinon | H | 1,228,066
Dicofol | F | 594,789
Dicofol | G | 113
Diphenoxylate | H | 596,014
Dinofac | C | 13
Dinoseb | C, E, G | 73
Di-n-propyl isocinchomerone | G | 1
Dapoxos | G, I | 97,688
Diuron | I | 1,071,028
Endosulfan | F, G, I | 238,455
Endochlor, dipotassium salt | G | 6,297
Endrin | E, G | 0
Epichlorohydrin | A, B, E | 0
Esfenvalerate | F | 44,698
Echion | H | 79
<table>
<thead>
<tr>
<th>Pesticide active ingredient</th>
<th>Hazard and Toxicity</th>
<th>Pounds of active ingredient</th>
<th>Pesticide active ingredient</th>
<th>Hazard and Toxicity</th>
<th>Pounds of active ingredient</th>
</tr>
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<tbody>
<tr>
<td>Ethoprop</td>
<td>G, I</td>
<td>51,104</td>
<td>Pronamidé 16</td>
<td>A, B</td>
<td>114.557</td>
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<td>Ethyl acrylate</td>
<td>B</td>
<td>95</td>
<td>Propanil</td>
<td>I</td>
<td>40,022</td>
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<tr>
<td>Ethylene dibromide</td>
<td>A, B, G</td>
<td>90</td>
<td>Propargite</td>
<td>A, B</td>
<td>1,799,584</td>
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<tr>
<td>Ethylene dichloride</td>
<td>A, B</td>
<td>0</td>
<td>Propetamphos</td>
<td>H</td>
<td>77,985</td>
</tr>
<tr>
<td>(1,2-dichloroethane)</td>
<td>B, D, G</td>
<td>0</td>
<td>Propoxur 17</td>
<td>A, G</td>
<td>3,296</td>
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<tr>
<td>Ethylene oxide</td>
<td>B, G</td>
<td>0</td>
<td>Propylene oxide</td>
<td>A, B</td>
<td>155,890</td>
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<tr>
<td>Fenamiphos</td>
<td>G, I</td>
<td>190,027</td>
<td>s.s.s-Tributyl phosphorothioate 18</td>
<td>I</td>
<td>885,595</td>
</tr>
<tr>
<td>Fenoxycarb</td>
<td>A</td>
<td>1,673</td>
<td>Simazine</td>
<td>I</td>
<td>841,310</td>
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<tr>
<td>Fenthon</td>
<td>H</td>
<td>413</td>
<td>Sodium cyanide</td>
<td>G, I</td>
<td>1,347</td>
</tr>
<tr>
<td>Fenvorcarb</td>
<td>F</td>
<td>25,770</td>
<td>Strychnine 19</td>
<td>G, I</td>
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<td>Folpet</td>
<td>A, B</td>
<td>2</td>
<td>Sulfopep</td>
<td>G, I</td>
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<tr>
<td>Fonofos</td>
<td>G</td>
<td>74,936</td>
<td>Sulfuryl fluoride</td>
<td>G</td>
<td>1,746,320</td>
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<tr>
<td>Formaldehyde (gas)</td>
<td>A, B, G</td>
<td>153,519</td>
<td>Sulprofos</td>
<td>H</td>
<td>171</td>
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<tr>
<td>Formetanate hydrochloride</td>
<td>G</td>
<td>104,846</td>
<td>Terazaole 20</td>
<td>A, B</td>
<td>369</td>
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<tr>
<td>Heptachlor</td>
<td>A, B, F</td>
<td>0</td>
<td>Tetrachloroethylene 21</td>
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<tr>
<td>Iprodione</td>
<td>A, B</td>
<td>58,301</td>
<td>Thiobencarb</td>
<td>I</td>
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<tr>
<td>Lindane</td>
<td>A, B, E, I</td>
<td>4,653</td>
<td>Thiodicarb</td>
<td>A, H</td>
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<tr>
<td>Malachlor</td>
<td>F</td>
<td>825,077</td>
<td>Toxaphene</td>
<td>A, B, E, G</td>
<td>1,353</td>
</tr>
<tr>
<td>Mancozeb</td>
<td>A, B, F</td>
<td>678,316</td>
<td>Tributyltin 22,23</td>
<td>F, G, I</td>
<td>338</td>
</tr>
<tr>
<td>Maneb</td>
<td>A, B, F</td>
<td>1,295,589</td>
<td>Trichlorfon</td>
<td>H</td>
<td>4,552</td>
</tr>
<tr>
<td>Metam sodium</td>
<td>A, I</td>
<td>15,131,385</td>
<td>Trifluralin</td>
<td>F</td>
<td>1,628,913</td>
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<tr>
<td>Methamidophos</td>
<td>G, I</td>
<td>515,127</td>
<td>Vinclorizol</td>
<td>A, F</td>
<td>49,869</td>
</tr>
<tr>
<td>Methanol</td>
<td>G</td>
<td>27</td>
<td>Warfarin</td>
<td>C, G</td>
<td>0</td>
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<tr>
<td>Methidathion</td>
<td>G, I</td>
<td>321,750</td>
<td>Zinc Phosphate</td>
<td>I</td>
<td>1,611</td>
</tr>
<tr>
<td>Methomyl</td>
<td>F, G, I</td>
<td>823,399</td>
<td>Zineb</td>
<td>B</td>
<td>494</td>
</tr>
<tr>
<td>Methoxychloride</td>
<td>F</td>
<td>1,049</td>
<td>Ziram</td>
<td>F</td>
<td>1,638,552</td>
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<tr>
<td>Methyl bromide 10</td>
<td>C, G, I</td>
<td>17,519,744</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl isothiocyanate 11</td>
<td>G, I</td>
<td>123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metolachlor</td>
<td>F</td>
<td>179,109</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metribuzin</td>
<td>F</td>
<td>30,670</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moviphenos</td>
<td>G, I</td>
<td>79,347</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molinate</td>
<td>I</td>
<td>1,411,346</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naled</td>
<td>G</td>
<td>708,927</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nicotinamate</td>
<td>C, G</td>
<td>235</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Nitrofen</td>
<td>B, F</td>
<td>24</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>o-Phenylphenol 17</td>
<td>A, B</td>
<td>49,178</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oradiazon</td>
<td>B</td>
<td>21,485</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxyamyl</td>
<td>G</td>
<td>66,403</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Oxynitrofen-methyl</td>
<td>G, I</td>
<td>121,949</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Oxyclophaneox</td>
<td>A</td>
<td>9,535</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parathion</td>
<td>G, I</td>
<td>862,832</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parathion, ethyl 14</td>
<td>F, G</td>
<td>13,642</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parathion, methyl 15</td>
<td>F, G</td>
<td>153,346</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-Dichlorobenzene</td>
<td>B</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permethrin</td>
<td>F</td>
<td>323,663</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phorate</td>
<td>G, I</td>
<td>135,887</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosalone</td>
<td>H</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosmet</td>
<td>H</td>
<td>267,886</td>
<td></td>
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<td></td>
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<tr>
<td>Phosphamidon</td>
<td>G</td>
<td>664</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium hydrogen peroxide</td>
<td>G</td>
<td>192</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefenos</td>
<td>H</td>
<td>245,809</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 2,4,5-T is listed as an endocrine disruptor. DPR Pesticide Use Reports have two listings for 2,4,5-T: (1) 2,4,5-T Busoxon ester. (2) 2,4,5-T Propylphenoxybutyl ester. We lump these two into the single listing, "2,4,5-T." 2 DPR Pesticide Use Reports specify a large number of related 2,4-D salts, esters, and amine esters, all of which are included here. 3 Aromatase is listed as a Restricted Use Pesticide when it is used as an agricultural herbicide. 4 Aroclor is classified here as an herbicide, but can also be used as a rodenticide. 5 2,4,5-T Busoxon ester is also known as parathion. 6 Parathion is also known as ethyl parathion and as parathion. 7 Parathion, methly is also known as methyl parathion. 8 Pronamidé is also known as Propamidé. 9 2,4,5-T is listed in the U.S. EPA's "p-phenylenediamine" as a catalyst; CA Proposition 65 states "p-phenylenediamine" as a carcinogen. 10 2,4-D triethyl phosphorothioate is also known as tribrom and EPE. 11 Tribrom is also known as triethyl phosphorothioate. 12 Tribrom is a Restricted Use Pesticide when it is labeled for control of "foul odors, or insect growth in an aquatic environment. 13 DPR Pesticide Use Reports for several related tributyl compounds are labeled as a Restricted Use Pesticide when they are labeled as a Restricted Use Pesticide.部落有两种 listing for 2,4,5-T: (1) 2,4,5-T Busoxon ester. (2) 2,4,5-T Propylphenoxybutyl ester. We lump these two into the single listing, "2,4,5-T." 2 DPR Pesticide Use Reports specify a large number of related 2,4-D salts, esters, and amine esters, all of which are included here. 3 Aromatase is listed as a Restricted Use Pesticide when it is used as an agricultural herbicide. 4 Aroclor is classified here as an herbicide, but can also be used as a rodenticide. 5 2,4,5-T Busoxon ester is also known as parathion. 6 Parathion is also known as ethyl parathion and as parathion. 7 Parathion, methly is also known as methyl parathion. 8 Pronamidé is also known as Propamidé. 9 2,4,5-T is listed in the U.S. EPA's "p-phenylenediamine" as a catalyst; CA Proposition 65 states "p-phenylenediamine" as a carcinogen. 10 2,4-D triethyl phosphorothioate is also known as tribrom and EPE. 11 Tribrom is also known as triethyl phosphorothioate. 12 Tribrom is a Restricted Use Pesticide when it is labeled for control of "foul odors, or insect growth in an aquatic environment. 13 DPR Pesticide Use Reports for several related tributyl compounds are labeled as a Restricted Use Pesticide when they are labeled as a Restricted Use Pesticide.
Appendix C
All Crops Listed in DPR's 1991–1996 Pesticide Illness Reports

Top ten crops: alfalfa, almonds, broccoli, cotton, grapes, lettuce, oranges, ornamentals, strawberries, tomatoes.

All other crops (as listed by DPR): anemones, apples, apricots, arbor vitae, artichokes, ash trees, asparagus, asters, avocados, azaleas, basil, beans, bedding plants, bell peppers, blackeyes, brussel sprouts, cabbage, cactus, coneflowers, carnations, carrots, castle, cauliflowers, celery, cherries, chives, chrysanthemums, citrus, corn, cucumbers, cut flowers, cyclamen, dates, dried prunes, eggplant, elm trees, eucalyptus, fallow, figs, flowers, freesias, furniture, garbanzo beans, gardenias, garlic, gladiolus, grapefruit, green onions, gypsophila, heather, hedge, herbs, honeydew melons, hydrangeas, impatiens, irises, kiwis, lemons, lilies, lima beans, loquats, lumber, melons, mums & kalanchoe, mushrooms, nectarines, nursery plants, nursery stock, oak trees, olives, onions, orchids, ornamental cactus, ornamental trees, pasture, peaches, pears, peppers, pine trees, pistachios, plums, poinsettias, pomegranates, potatoes, potted begonias, potted plants, primulas, prunes, pyracantha, raisins, raffini, rice, roses, safflower, sauge, seed, seed garlic, seed potatoes, seedlings, snapdragons, spinach, squash, stone fruit, sugarcane, sunflowers, sweet corn, tangelo, tarragon, tomatillos, trees, tulips, turf, turkeys, veronicas, walnuts, watermelon, wheat.

Appendix D
Proportion of the Most Toxic* Pesticides Among Possible Poisoning Agents in Top 10 Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Proportion of Most Toxic Agents of All Agents Listed**</th>
</tr>
</thead>
<tbody>
<tr>
<td>alfalfa</td>
<td>55.7</td>
</tr>
<tr>
<td>almonds</td>
<td>48.6</td>
</tr>
<tr>
<td>broccoli</td>
<td>54.7</td>
</tr>
<tr>
<td>cotton</td>
<td>38.0</td>
</tr>
<tr>
<td>grape</td>
<td>19.9</td>
</tr>
<tr>
<td>lettuce</td>
<td>57.8</td>
</tr>
<tr>
<td>oranges</td>
<td>55.2</td>
</tr>
<tr>
<td>ornamentals</td>
<td>34.8</td>
</tr>
<tr>
<td>strawberries</td>
<td>33.9</td>
</tr>
<tr>
<td>tomatoes</td>
<td>33.0</td>
</tr>
<tr>
<td>other crops</td>
<td>33.9</td>
</tr>
<tr>
<td>no crop listed</td>
<td>32.3</td>
</tr>
</tbody>
</table>

* These include pesticides categorized as carcinogens, nerve toxins, respiratory irritants, reproductive toxins, production delays, and acute systemic toxins (Naranjo 1997).

** Since most compounds are listed more than once, these numbers represent the proportion of all listings of the most toxic compounds to the total of all listings of all compounds.
# Appendix E

Top 7 Activities Associated with Pesticide Exposure (% of Total Number of Cases)

<table>
<thead>
<tr>
<th>Activity</th>
<th>grapes</th>
<th>cotton</th>
<th>broccoli</th>
<th>oranges</th>
<th>ornamental</th>
<th>almonds</th>
<th>tomato</th>
<th>lettuce</th>
<th>strawb.</th>
<th>alfalfa</th>
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<tbody>
<tr>
<td>ground application</td>
<td>13.4</td>
<td>4.0</td>
<td>0.7</td>
<td>13.9</td>
<td>0.0</td>
<td>44.1</td>
<td>3.9</td>
<td>5.0</td>
<td>23.1</td>
<td>2.9</td>
</tr>
<tr>
<td>hand application</td>
<td>4.3</td>
<td>1.0</td>
<td>0.7</td>
<td>2.4</td>
<td>34.6</td>
<td>2.9</td>
<td>4.9</td>
<td>2.0</td>
<td>5.1</td>
<td>4.3</td>
</tr>
<tr>
<td>drift exposure</td>
<td>7.6</td>
<td>79.7</td>
<td>84.7</td>
<td>12.1</td>
<td>17.3</td>
<td>10.8</td>
<td>27.5</td>
<td>22.8</td>
<td>23.1</td>
<td>25.7</td>
</tr>
<tr>
<td>drift into neighboring areas*</td>
<td>1.5</td>
<td>2.5</td>
<td>2.3</td>
<td>32.1</td>
<td>16.3</td>
<td>8.8</td>
<td>3.9</td>
<td>2.0</td>
<td>0</td>
<td>31.4</td>
</tr>
<tr>
<td>mix/loading, ground application</td>
<td>2.2</td>
<td>2.5</td>
<td>0</td>
<td>3.6</td>
<td>0</td>
<td>11.8</td>
<td>2.0</td>
<td>3.0</td>
<td>6.4</td>
<td>0</td>
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<tr>
<td>packing/processing</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>4.8</td>
<td>0</td>
<td>2.0</td>
<td>18.6</td>
<td>2.0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>field residues</td>
<td>66.8</td>
<td>7.5</td>
<td>10.4</td>
<td>30.3</td>
<td>22.1</td>
<td>6.9</td>
<td>30.4</td>
<td>56.4</td>
<td>42.3</td>
<td>30.0</td>
</tr>
<tr>
<td>Total # cases</td>
<td>539</td>
<td>399</td>
<td>307</td>
<td>165</td>
<td>104</td>
<td>102</td>
<td>102</td>
<td>101</td>
<td>78</td>
<td>70</td>
</tr>
<tr>
<td>Percent of Total Included**</td>
<td>95.7</td>
<td>97.2</td>
<td>99.0</td>
<td>99.4</td>
<td>99.4</td>
<td>87.3</td>
<td>91.0</td>
<td>93.1</td>
<td>100</td>
<td>94.3</td>
</tr>
</tbody>
</table>

Other activities in dataset included: aerial application, cleaning/loading equipment, exposure to concentrate, fumigation chamber, field fumigation, crop fumigation, mixing/loading, aerial, mixing/loading, hand.

* Drift into non-targeted sites.

** Due to rounding, the sum of the percentages may not equal the total shown in the last row.
### Appendix F

**Pesticide Poisonings by County, 1991–1996**

<table>
<thead>
<tr>
<th>County</th>
<th>Total # cases</th>
<th>Main Crop(s)</th>
<th>% of county cases</th>
<th>County</th>
<th>Total # cases</th>
<th>Main Crop(s)</th>
<th>% of county cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kern</td>
<td>534</td>
<td>Cotton 239</td>
<td>44.8</td>
<td>San Mateo</td>
<td>35</td>
<td>Ornaments 9</td>
<td>25.7</td>
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<tr>
<td></td>
<td></td>
<td>Grapes 121</td>
<td>22.7</td>
<td></td>
<td></td>
<td>Flowers 8</td>
<td>22.9</td>
</tr>
<tr>
<td></td>
<td>515</td>
<td>No crop 157</td>
<td>30.5</td>
<td>Sacramento</td>
<td>29</td>
<td>No crop 12</td>
<td>41.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grapes 136</td>
<td>26.4</td>
<td>Sutter</td>
<td>26</td>
<td>No crop 10</td>
<td>38.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No crop 79</td>
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</table>

* Crops listed together for each county account for at least 50% of total poisoning cases in that county.

**When no crop was identified in the DPR data, the term 'no crop/land' is used.

**** Different flowers are grouped here and are listed, along with all other crops, in Appendix C.

Source: California DPR 1999
# Appendix G


### Fines for Violations of Pesticide Handler Protections, 1991–1996

<table>
<thead>
<tr>
<th>Reg. #</th>
<th>Description</th>
<th># Times Cited</th>
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<tbody>
<tr>
<td>6738</td>
<td>Provision and Maintenance of Protective Gear</td>
<td>1,155</td>
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<td>6736</td>
<td>Coveralls for Category I and II Pesticides</td>
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<tr>
<td>6793</td>
<td>Minimal Exposure Pesticides Protections</td>
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<tr>
<td>6746</td>
<td>Closed Systems for Category I Pesticides</td>
<td>72</td>
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<tr>
<td>6678</td>
<td>Service Containers Labeled</td>
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<tr>
<td>6742</td>
<td>Safe Equipment</td>
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**Training/Supervision/Warning**

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<tr>
<td>6724</td>
<td>Training of Pesticide Handlers</td>
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</tr>
<tr>
<td></td>
<td>In a manner employee understands</td>
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</tr>
<tr>
<td></td>
<td>Pesticide-specific training</td>
<td>(175)</td>
</tr>
<tr>
<td></td>
<td>Inadequate training records</td>
<td>(99)</td>
</tr>
<tr>
<td>6702</td>
<td>Employer Responsibility</td>
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<td>6723</td>
<td>Hazard Communication for Handlers</td>
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**Emergency Medical Care/Wash Facilities**

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<tr>
<td>6726</td>
<td>Adequate Provision for Emergency Medical Care</td>
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<tr>
<td>6602</td>
<td>Pesticide Labels at Use Site</td>
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<tr>
<td>6734</td>
<td>Decontamination Facilities for Handlers</td>
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</tr>
<tr>
<td>6728</td>
<td>Medical Supervision</td>
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### Fines for Drift, Negligence, Unlicensed Businesses 1991–1996

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</thead>
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<td>6614</td>
<td>Duty to Protect Persons, Animals, Property</td>
<td>260</td>
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<tr>
<td>6434</td>
<td>Notice of Intent (NOI)</td>
<td>149</td>
</tr>
<tr>
<td>6600</td>
<td>General Standard of Care</td>
<td>113</td>
</tr>
<tr>
<td>12972</td>
<td>Failure to Prevent Substantial Drift</td>
<td>42</td>
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<tr>
<td>11791</td>
<td>False Claim, Careless Negligent Action</td>
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<tr>
<td>11701</td>
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### Fines for Violations of Fieldworker Protections 1991–1996

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<td>44</td>
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<td>6732</td>
<td>Field Posting During Restricted Entry Intervals</td>
<td>32</td>
</tr>
<tr>
<td>6618</td>
<td>Notice of Applications to and by Property Owner</td>
<td>31</td>
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<tr>
<td>6761</td>
<td>Hazard Communication for Fieldworkers</td>
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<tr>
<td>6766</td>
<td>Emergency Medical Care Provision</td>
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<tr>
<td>6768</td>
<td>Wash Facilities for Fieldworkers</td>
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<tr>
<td>6776c</td>
<td>Chemigation Posting</td>
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## Appendix H

Number of Fines by Fine Level—Statewide Total, FY1991/92–1995/96

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Minor Violation &lt;$151 (%)</th>
<th>Moderate Violation $151–400 (%)</th>
<th>Serious Violation $401–1,000 (%)</th>
<th>&gt;$1,000 (%)</th>
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</thead>
<tbody>
<tr>
<td>1991/92</td>
<td>321 (47%)</td>
<td>223 (33%)</td>
<td>116 (17%)</td>
<td>23 (3%)</td>
</tr>
<tr>
<td>1992/93</td>
<td>281 (42%)</td>
<td>233 (35%)</td>
<td>122 (18%)</td>
<td>33 (5%)</td>
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<tr>
<td>1993/94</td>
<td>394 (48%)</td>
<td>276 (34%)</td>
<td>121 (15%)</td>
<td>23 (3%)</td>
</tr>
<tr>
<td>1994/95</td>
<td>342 (46%)</td>
<td>248 (34%)</td>
<td>130 (18%)</td>
<td>18 (2%)</td>
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<tr>
<td>1995/96</td>
<td>264 (45%)</td>
<td>209 (35%)</td>
<td>101 (17%)</td>
<td>16 (3%)</td>
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<tr>
<td>1996/97</td>
<td>309 (45%)</td>
<td>251 (37%)</td>
<td>106 (15%)</td>
<td>19 (3%)</td>
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</table>

Source: California DPR 1998
## Appendix I

**Average Annual Pesticide Fines—All Counties, FY1991/92–1996/97**

<table>
<thead>
<tr>
<th>County</th>
<th>Number of Fines per Year</th>
<th>Average Annual Total Fines</th>
<th>1996 Ag. Pesticide Illnesses</th>
<th>1995 Ag. Prod. Pesticide Use (Thousands lbs.)</th>
<th>1996/97 Restricted Pesticide Use</th>
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<td>Alameda</td>
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<tr>
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<td>7.2</td>
<td>1,833</td>
<td>10</td>
<td>3,925</td>
<td>561</td>
</tr>
<tr>
<td>Stanislaus*</td>
<td>5.7</td>
<td>2,075</td>
<td>26</td>
<td>5,504</td>
<td>2,811</td>
</tr>
<tr>
<td>Sutter</td>
<td>15.5</td>
<td>3,308</td>
<td>5</td>
<td>3,497</td>
<td>1,549</td>
</tr>
<tr>
<td>Tehama</td>
<td>8.0</td>
<td>2,080</td>
<td></td>
<td>895</td>
<td>433</td>
</tr>
<tr>
<td>Tulare</td>
<td>16.7</td>
<td>8,402</td>
<td>43</td>
<td>17,927</td>
<td>5,809</td>
</tr>
<tr>
<td>Tioga</td>
<td>1.7</td>
<td>800</td>
<td></td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Ventura</td>
<td>5.5</td>
<td>1,671</td>
<td>42</td>
<td>5,553</td>
<td>1,475</td>
</tr>
<tr>
<td>Yolo</td>
<td>27.2</td>
<td>4,104</td>
<td>10</td>
<td>3,120</td>
<td>1,097</td>
</tr>
<tr>
<td>Yuba</td>
<td>2.2</td>
<td>800</td>
<td></td>
<td>1,735</td>
<td>474</td>
</tr>
</tbody>
</table>

*Note: Agricultural Civil Penalties fines were assessed by San Joaquin or Mendocino counties in Fiscal Year 1989-90.*


48
**Appendix J**

Common Actions for Pesticide Safety Violations—Santa Barbara, Santa Cruz, Monterey Counties

<table>
<thead>
<tr>
<th>Type of Violation</th>
<th>No Action</th>
<th>Notice/Warning</th>
<th>Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>No washing facilities for applicators</td>
<td>5</td>
<td>12</td>
<td>1**</td>
</tr>
<tr>
<td>No Monterey County required field posting</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Field not posted prior to application</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fieldworker Pesticide Info Sheet A-9</td>
<td>13</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>not posted at field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate protective gear not provided</td>
<td>36</td>
<td>39</td>
<td>21***</td>
</tr>
<tr>
<td>Application equipment not safe to operate</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Inadequate respiratory protection program</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>No field posting</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No washing facilities for fieldworkers</td>
<td>28</td>
<td></td>
<td>3***</td>
</tr>
<tr>
<td>Inadequate or no fieldworker training</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Violation of methyl bromide buffer zone</td>
<td>2</td>
<td></td>
<td>4***</td>
</tr>
<tr>
<td>Methyl bromide reentry interval violation</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No applicator training</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field supervisor not trained in pesticide safety</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Percent of Total</strong></td>
<td>28%</td>
<td>67%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

* Only violations not resulting in illness are included in this table. For actions resulting from illness investigations see Chapter 4.
** Fine level $200-$450
*** Fine level $151

APPENDIX S
Manure and Microbes: Public and Animal Health Problem?

ABSTRACT

Most environmental concerns about waste management either have focused on the effects of nutrients, especially N and P, on water quality or have emphasized odor problems and air quality. Microbes from manure are often low on the priority list for control and remediation, despite the fact that several outbreaks of gastroenteritis have been traced to livestock operations. The pathogens discussed in this paper include protozoans (Cryptosporidium parvum, Giardia spp.), bacteria (Listeria monocytogenes, Escherichia coli O157:H7, Salmonella spp., and Mycobacterium paratuberculosis), and some enteric viruses. Clinical symptoms, prospects for zoonotic infection, and control methods other than the use of antimicrobials are considered. Recommendations to avoid disease transmission include taking steps to ensure the provision of clean, unstressful environments to reduce disease susceptibility and the careful handling and spreading of manure from animals at high risk for infection, especially young calves. Composting and drying of manure decrease the number of viable pathogens. Environmental controls, such as filter strips, also reduce the risk of water contamination.

(Key words: manure, pathogen, water quality, waste management)

INTRODUCTION

Maintaining profitability in the dairy industry while protecting water quality and the health of humans and animals is one of the challenges that farmers face in the 1990s. Run-off of sediment, pesticides, and nutrients such as phosphorus and nitrogen have been considered the greatest environmental threats to water quality posed by animal agriculture.

Pathogen contamination of the water and food supplies recently has received national attention because of the presence of Escherichia coli O157:H7 in hamburgers, Salmonella spp. in ice cream and eggs, and Cryptosporidium parvum in the Milwaukee water supply (32). In the ice cream and hamburger cases, livestock were not directly linked to the outbreaks, but, as reservoirs of these pathogens, animals were indirectly involved. In Milwaukee, a malfunctioning water treatment plant was the direct cause of the outbreak of diarrhea that made 403,000 people sick (32), and there is still debate about the original source of the oocysts.

Protozoan pathogens (C. parvum and Giardia spp.); bacteria including Salmonella spp., E. coli O157:H7, Listeria monocytogenes, and Mycobacterium paratuberculosis; and viruses in the food and water supply can cause these headline-grabbing outbreaks. The goal of this paper is to identify which microbes are of most concern, to review the potential sources of these microbes, and to describe farm level approaches to minimize human and animal infection. The discussion is limited to cattle, especially dairy cows. This distinction is important because many swine enteroviruses can infect humans, and organisms such as Campylobacter spp., which are major problems for the swine and poultry industries, are of somewhat less concern to the dairy industry. The microbes to be discussed were selected based on the likelihood of transmission from dairy cattle to humans, and the potential threat to human health. In some cases, such as Yersinia enterocolitica and Campylobacter jejuni, the decision was difficult; these bacteria pose significant risks to human health, and they are found in cattle feces, but they are more frequently found in poultry and swine manure.

When considering the problem of pathogen transmission through manure, it is important to recognize that manure, which consists of animal excreta (feces and urine), bedding, and dilution water, also contains secretions from the nose, throat, blood, vagina, mammary gland, skin, and placenta. Microbes in these secretions, as well as those in the excreta, can potentially accumulate on the barn floor. Unless the manure is handled appropriately, these pathogens may infect other animals or humans. Aside from the problem of disease transmission among animals, more than 150 pathogens can cause zoonotic infec-
tions (from animals to humans) (52). Slurry, like manure, contains excreta but does not contain significant amounts of bedding. This distinction has important implications for handling strategies because slurry is more difficult to compost than manure is (25). For materials to reach 60°C in 3 d, a target for composting, they should contain at least 30% DM.

Manure or slurry handling may cause organisms to become airborne. A Dutch composting facility significantly exceeded the Dutch standards for total airborne bacteria (42) in an air quality study. However, when air quality was monitored after land application of anaerobically digested sewage sludge, the risk of transmission of Salmonella and pathogenic clostridia was low (41).

**BACTERIA**

The Commission of the European Communities identified reportable bacteria that are of particular concern for animal and human health ([27] as cited in [52]). Included in their list are Salmonella spp., E. coli, Bacillus anthracis, Mycobacterium spp., Brucella spp. (especially Brucella abortus), Leptospira spp., Chlamydia spp., and Rickettsia spp. In addition to these organisms, other potential bacterial pathogens in manure include L. monocytogenes, Y. enterocolitica, Clostridium perfringens, and Klebsiella spp. (34). In this review, the emphasis is on L. monocytogenes, Salmonella spp., M. paratuberculosis, and E. coli O157:H7 because outbreaks caused by these organisms have been linked, tentatively in some cases, to cattle. All of these organisms can be transmitted from animals to humans directly or through the food and water supplies. Although anthrax is usually fatal, salmonellosis, listeriosis, and infection with E. coli O157:H7 are of greater public health concern currently because the bacteria that cause these infections have multiple hosts, and the prevalence of infection has increased over the past 20 yr (81). Mycobacterium paratuberculosis has been included in this review because the issue of whether there is a link between M. paratuberculosis and Crohn's disease has been raised. Mycobacterium paratuberculosis also is an organism that can have severe economic impacts on infected herds.

To assess the threat posed by different microorganisms in manure, bacterial survival in manure as it is usually handled on farms must be evaluated. Survival is affected by the source, pH, dry matter content, age, and chemical composition of the manure as well as by microbial characteristics. Manure that is well mixed with bedding is more likely to undergo aerobic fermentation with accompanying temperature increases than is slurry with minimal amounts of bedding. Because of their ability to grow under a wide range of conditions, organisms such as L. monocytogenes and M. paratuberculosis (2, 46) are widely dispersed in the environment, making their control difficult. The endospores of spore-forming bacteria such as C. perfringens and B. anthracis often withstand much harsher environmental conditions than the bacteria themselves can tolerate.

Sensitive 16S rRNA or DNA probes, which now exist for most of the bacteria mentioned in this paper, have resulted in an improved ability to detect low levels of most of these organisms (13, 33). However, these methods require careful sample handling and the use of sophisticated laboratories to ensure complete DNA extraction without contamination. Without these methods, scientists are still dependent on the ability to culture and enrich for these bacteria. In some cases, such as Salmonella, the conventional methods are quite sensitive, but some of the leptoospira and mycobacteria are difficult to grow. For example, the conventional culture techniques for Mycobacterium spp. may require more than 8 wk (46, 48) and have a sensitivity of 40 to 50% (48).

Manure (excreta plus bedding) typically contains 10^10 cells/ml. Manure in England typically contains less than 10^2 Salmonella cells/g of feces, but this number may be as high as 10^9 cells/g in the feces of apparently healthy animals (25, 51). To bring the problem more clearly into focus, as few as 10 cells of some pathogens may be enough to cause infection. Rapidly changing pathogen numbers, combined with culture problems and changes in infective dose because of the immune status of the host, make quantification of risk difficult.

**E. coli O157:H7**

Verotoxin-producing strains of E. coli, such as strain O157:H7, present problems because the symptoms they can cause are serious, and the bacteria can survive under adverse conditions. The verotoxins produced by E. coli O157:H7 can produce three different sets of symptoms, including hemorrhagic colitis (diarrhea that becomes profuse and bloody), hemolytic uremic syndrome (bloody diarrhea followed by renal failure), and thrombocytopenic purpura (symptoms similar to those of hemolytic uremic syndrome with central nervous system involvement in addition). Death often occurs in patients with hemolytic uremic syndrome and thrombocytopenic purpura. This organism is of concern to the dairy industry because many outbreaks have been traced to ground beef and some to raw milk (7, 18) as well as to water,
apple cider (1), and vegetables (56). Dairy farms have been identified as reservoirs of E. coli O157:H7 (22, 57, 60). It was suggested, but not proven, that the apples that were the source of the E. coli O157:H7 in the Massachusetts cider outbreak had been contaminated by manure that had been deposited under the trees (1). Research on E. coli O157:H7 in dairy cattle from Washington (22), Wisconsin and Washington (57) and two national US studies (20, 60) indicate that the prevalence of this bacterium is less than 5% and usually lower than 1%. It is difficult to compare these studies because different detection methods of varying sensitivities, sample collection strategies, age grouping, and number of samples collected were used. In the Washington study (22), E. coli O157:H7 was isolated from 0.28% (10 of 3570) of the fecal grab samples from dairy animals in 60 herds but not from samples of slurry (fences and urine), bulk milk, or milk filtrates from these farms. In studies that included 1266 samples from 22 farms in Wisconsin and Washington, 2 of which had been linked to an outbreak of gastroenteritis after consumption of raw milk (57), only 1 mature cow of the 662 tested (0.15%) was positive. The heifers and calves under 24 mo of age, however, were more likely to excrete E. coli O157:H7 (2.3%). Recovery of E. coli O157:H7 was three times more likely on the case farms than on the control farms. Samples were collected from 64 and 50 control herds in 14 states in the national studies, one of which was conducted in 1991 to 1992 (20) and the follow-up study that took place in 1993 to 1994 (60). In addition, 3 case herds were sampled from the first study and 14 case herds were sampled from the second study in which E. coli O157:H7 had been identified.

The important conclusions from these studies were that 1) the weaned calves less than 24 mo old were more likely to shed E. coli O157:H7 than were the milk-fed calves, 2) very few mature cows shed the pathogen, and 3) neither detection method consistently isolated the pathogen, or shedding was intermittent. Two animals were positive for E. coli O157: H7 for more than a year after the initial isolation, but intermediate samples did not always yield positive results. Intermittent shedding does occur with many organisms and must be considered as studies are designed to evaluate prevalence of these organisms. The second study indicated that 22% of the control herds and 50% of the case farms were positive for E. coli O157:H7 (60) and that a relatively small number of animals excreted the organisms on each farm.

How cattle are managed affects whether E. coli O157:H7 is able to proliferate in the rumen (44). The gastrointestinal tracts of well-fed cattle were far less conducive to the growth of E. coli O157:H7 than the gastrointestinal tracts of cattle that had been deprived of feed, possibly because of the high VFA concentrations and lower pH in the well-fed cattle. Both the ruminal and hindgut fermentations probably affect excretion of E. coli O157:H7. This finding has some practical implications: 1) to reduce the likelihood of contamination at the meat processing plant by the pathogen, animals that are shipped to the slaughterhouse should not be deprived of feed, and 2) surveys conducted with well-fed cattle may not reflect the true prevalence of E. coli O157:H7 (44).

The fate of E. coli O157:H7 after excretion is important in determining whether the organism is introduced into the water or food supply or is transmitted to humans and other animals. That E. coli O157: H7 could survive at 8°C and pH <4.0 for up to 31 d in apple cider (59) or in hard salami with its high levels of nitrates, nitrites, and salt (4) shows that E. coli O157:H7 is an organism able to grow in adverse environments.

Several trials have been conducted to determine the viability of E. coli O157:H7 in manure with various amounts of bedding and under a variety of storage conditions. The survival times of E. coli O157: H7 at 5, 22, and 37°C with an initial inoculum of 10^6 cfu/g were 70, 56, and 49 d, respectively (56). Treatment of manure by mesophilic digestion caused a rapid initial decline in the numbers of viable E. coli, but this decrease was followed by a period during which the residual population was maintained for an extended period (26).

L. monocytogenes

Any bacterium that is able to cause severe neurological symptoms and death in humans and that has been isolated from 42 mammals, 22 species of birds, and from fish, crustaceans, and insects (8) is a potentially dangerous organism. Listeria monocytogenes is such a bacterium. In addition, L. monocytogenes lives naturally in plant and soil environments, and poorly fermented silage often contains high numbers of L. monocytogenes (21, 24, 58). Outbreaks from raw vegetables that had been fertilized with sheep manure have been documented, as have infections associated with consumption of unpasteurized dairy products and with ice cream that had been infected during processing (23, 38, 55). Healthy animals can be asymptomatic carriers of L. monocytogenes.

In a 2-yr epidemiological study with 3878 fecal samples from 249 dairy herds, more cows excreted L. monocytogenes.
monocytogenes during the winter than during the summer; 16.1% of the cows tested positive in December. There was a strong positive correlation between the presence of L. monocytogenes and whether silage was fed. The ability of this bacterium to grow at a wide range of temperature (3 to 42°C) and pH (5.5 to 9.0) and in high (up to 12%) salt concentrations makes its control difficult (2).

Salmonella spp.

The best known member of the Salmonella genus is Salmonella typhi, the organism responsible for typhoid fever, but many of its near relatives, including Salmonella typhimurium, Salmonella dublin, and Salmonella enteritidis, are also gaining notoriety as formidable pathogens. Salmonella spp. have been responsible for 45% of the foodborne disease cases in which the causative agent has been identified (31). Many of these outbreaks of gastroenteritis have been traced to foods of animal origin, including eggs (54), although numerous other sources, including fish, coconut, salad dressing, peanut butter, and chocolate, have been implicated (18). The economic costs of salmonellosis have been estimated at close to $1 billion/year (31). In addition to links to foodborne disease, outbreaks from Salmonella spp. contamination of water have been documented (5). Symptoms of salmonellosis include nausea, vomiting, cramps, diarrhea, and, in about 2% of the cases, arthritis (18). Immunocompromised patients, especially those with AIDS, are at high risk.

Outbreaks linked to the dairy industry have occurred from contamination of a finished product with raw milk (18) and because a truck used to transport ice cream mix was not properly cleaned after contaminated eggs had been carried in the vehicle (23).

The incidence of Salmonella spp. infections has increased substantially since reporting began in 1943, especially since 1970 (54). The problem has been exacerbated by increasing antimicrobial resistance among Salmonella spp. serotypes. One of the consequences of antimicrobial resistance is that Salmonella spp. become a larger proportion of the microbial population because competing organisms are unable to grow and the risk of infection increases.

M. paratuberculosis

Paratuberculosis, or Johne's disease, is caused by M. paratuberculosis. The disease is difficult to control because much of the infection in a herd is invisible for an extended period before clinical symptoms are evident. The bacterium has ample opportunity to become entrenched in the herd before it is apparent that a problem exists. Mycobacterium paratuberculosis may be transmitted perinatally or postnataally, when most infection occurs through the fecal-oral route (53). The question of prenatal transmission has been controversial, but documentation is abundant that the organism can migrate from the intestinal tract to other organs, including the uterus, the lymphatic system, the udder, and the sex organs of bulls. There is some evidence for sexual transmission of the organism. Young calves are most vulnerable to M. paratuberculosis, but the immune resistance of yearlings is comparable with that of mature cattle. Removal of the calf from the dam at birth before nursing is one strategy that helps reduce the incidence of Johne's disease (48).

Although M. paratuberculosis is a very costly pathogen to the producer whose herd is infected, it probably would not have been included in this review had not a linkage between M. paratuberculosis and Crohn's disease been reported in 1984. Crohn's disease is a hyperresponsiveness of the intestinal immune system, which causes an abnormal inflammatory response (3). Patients suffering from this condition suffer from abdominal pain, weight loss, diarrhea or constipation, vomiting, and malaise. Studies of twins suggest that there is a genetic linkage in Crohn's disease (16).

Chioldini and Rossiter (3) recently wrote an excellent review of the evidence that M. paratuberculosis is implicated in the etiology of Crohn's disease. The scientific issues are complex. The available detection methods are inadequate, producing variable results because of the difficulty in growing the organism, and the immunologic responses to M. paratuberculosis have been inconsistent. Results using antinocobacterial drugs have varied. Furthermore, knowledge is incomplete concerning the drug susceptibilities of the cell-wall deficient forms of the organism, and M. paratuberculosis is resistant to many antimicrobials. Finally, many needed epidemiological studies have not been conducted. Unfortunately, we will not soon have a clear answer to whether M. paratuberculosis causes Crohn's disease. Recent advances using the polymerase chain reaction have improved detection methods significantly (14, 16), and progress in this area is continuing. Once the methodological problems have been resolved, experiments are needed to determine whether the DNA insertion element that is specific for M. paratuberculosis is found in the tissues of Crohn's patients. Accompanying immunologic experiments would provide additional insight into the relationship between M. paratuberculosis and Crohn's disease.

TABLE 1. List of zoonotic viruses and environmentally stable viruses that are likely to be isolated from dairy cattle (12).

<table>
<thead>
<tr>
<th>Zoonoses</th>
<th>Environmentally stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccinia</td>
<td>Adenovirus</td>
</tr>
<tr>
<td>Pseudorabies</td>
<td>Parvovirus</td>
</tr>
<tr>
<td>Bovine papular stomatitis</td>
<td>Acute respiratory and enteric disease</td>
</tr>
<tr>
<td>Bovine rotavirus</td>
<td>Bovine rotavirus</td>
</tr>
<tr>
<td>Bovine respiratory virus</td>
<td>Astrovirus</td>
</tr>
<tr>
<td>Vesticular stomatitis</td>
<td>Bovine enterovirus</td>
</tr>
<tr>
<td>Rift Valley Fever virus</td>
<td>Rift Valley Fever virus</td>
</tr>
<tr>
<td>Rabies</td>
<td>Rabies</td>
</tr>
</tbody>
</table>

1Possible, but not common.
2Humans are likely reservoirs of infection.
3Primarily found in Africa.

Given this uncertain association between M. paratuberculosis and Crohn's disease, how should the dairy industry approach the problem? Decreasing the level of M. paratuberculosis infection in dairy herds is a logical goal even without the Crohn's disease problem, because the disease is costly in terms of lost milk and shortened cow life. Roseiter and Burbans (48) have suggested a practical strategy on how to develop programs to control M. paratuberculosis on the farm. Their program involves collection of information and history, identification of risks specific to the farm, examination of control options, planning the scope and time frame for the control strategy, and implementation and evaluation of the control program.

**VIRUSES**

Problems are also posed by viruses, which are obligate intracellular parasites (49) that often have a limited host range. Similar to the protozoans described in the next section, viruses are unable to replicate outside of their host, and, therefore, their numbers never increase once they are released into the environment. Because of the limited host range, relatively few zoonotic viruses infect cattle and humans. Table 1 includes a list of these zoonoses (12) and viruses isolated from cattle that are environmentally stable. Table 2 is a list of viruses likely to be found in manure (51).

In trials in which cattle manure was inoculated with a bovine enterovirus and a bovine parvovirus, inactivation occurred within 30 min during thermophilic anaerobic digestion at 56°C (36). The enterovirus survived for up to 12 d under mesophilic conditions (35°C). Neither of these two environmentally resistant viruses survived aerobic composting for 26 d when the temperature reached 60°C on the 3rd d and was maintained at that temperature for the remainder of the fermentation.

Knowledge is incomplete about the viral attributes and environmental factors that contribute to viral inactivation (40). The stability of different viruses varied, apparently depending on whether the virus particle was adsorbed to or embedded within suspended solids (40). Other factors that affect viral survival include pH, temperature, and the presence of bacteria that can inactivate viruses (10). There is evidence (10) that some bacteria isolated from manure have both proteases and other strategies to inactivate viruses. Laboratory experiments supported previous work that showed that both hepatitis A and polio type 1 viruses were inactivated more rapidly in swine and dairy slurries than when the septic tank effluent containing intentionally added viruses was incubated alone (9, 11, 52).

Viruses were inactivated more rapidly during summer than during winter, but the effect was likely due to a more active microbial fermentation than to direct temperature effects. Samples kept in the laboratory at 4°C without significant fermentation were most likely to survive. The rotaviruses tested remained active for long periods.

Viral groundwater contamination has been a concern, particularly with wastewater irrigation systems. A preliminary study in Texas showed that low levels of bacteria but no viruses in irrigated wastewater inoculated with test organisms reached 1.37 m below the soil surface, although virus particles were present at 0.91 m (37). The distance viral particles can be transported is dependent on many factors, including soil moisture, pH, the adsorptive capacity of the soil,

| TABLE 2. List of viruses that might be excreted by cattle.1 |
|-----------------|-----------------|
| Enveloped       | Nonenveloped    |
| Bovine enterovirus2 | Infectious bovine     |
| Bovine adenovirus | Reticuloendotheliosis2 |
| Bovirus2         | Malignant eotetrial fever |
| Bovine parvovirus2 | Bovine maxillitis |
| Bovine rhinovirus | Bovine virus diarrhea2 |
| Bovine papillomavirus | Foot-and-mouth |
|                 | Bovine coronavirus2 |
|                 | Parainfluenza type2 |
|                 | Respiratory syncytial virus |
|                 | Rabies2 |
|                 | Vesticular stomatitis3 |
|                 | Cowpox3 |
|                 | Paravaccinia2 |

1Modified from a report by Strachan and Ballalini (52).
2Most likely to be found in feces.
3Unlikely to be found in feces.
and ionic concentration. Whether there is danger of groundwater contamination depends on these factors as well as on the depth of the water table.

PROTOZOA

*Giardia* app. and *C. parvum* are protozoa that cause severe diarrhea in both animals and humans. In 1983 to 1994, one-third of the outbreaks associated with drinking water for which the causative agent was identified were due to these two pathogens (23). In a large national study, 3.8% of the more than 414,000 stool samples tested were positive for *Giardia*. Age and community affected infection rate significantly; the range varied from 2 to 20% of the population (6). *Giardiasis* is transmitted by the fecal-oral route, by contact with infected individuals, or by consumption of contaminated drinking water or food (6). Despite the fact that *Giardia* was one of the first "free animals" identified by van Leeuwenhoek in the 17th century, the taxonomy of this genus is not well understood, and more research is needed to determine which species can infect humans.

*Cryptosporidium parvum*, first identified in 1907, was not considered pathogenic until 1976 (47). In healthy, mature animals (including humans), the infections caused by both *Giardia* and *C. parvum* are usually self-limiting and, although they cause significant discomfort, do not pose serious long-term health risks. In studies with healthy humans, the infection rate in 50% of the population was 132 (15). Eighty-eight percent of the volunteers became sick when they received more than 300 oocysts. Infected animals may shed as many as $1 \times 10^9$ oocysts daily for 1 to 12 d (45). These data, combined with the information from the Milwaukee outbreak in which 403,000 predominantly healthy people became ill (52), show that cryptosporidiosis is not restricted to the old, the infirm, and those with poorly functioning immune systems. Farmers, animal handlers, veterinarians, and others who work with animals are more likely to be infected than the general population (30). The impact of the disease is far more serious for people with AIDS and for those who are receiving chemotherapy or who have had organ transplants than for those who are not immunocompromised. Although many drugs have been tested for activity against *C. parvum*, the only drug that has proved effective is paromomycin (17). Although more drugs are effective against *Giardia*, the treatment options are still limited.

The life cycles of *Giardia* and *C. parvum* are similar in many ways. Both have complicated life cycles and change forms several times. In both organisms, infection occurs in the gastrointestinal tract of the host animal. When an animal ingests an oocyst (*C. parvum*) or cyst (*Giardia*), these structures excyst in the intestine, releasing an infectious form of the organism. Several stages occur before the organisms are excreted back into the environment as cysts or oocysts. These cysts or oocysts can resist many environmental pressures, which enables them to remain viable in the environment for at least a year (8). Of the two pathogens, *C. parvum* is the most difficult to control because it is not affected by chlorination at levels that are considered safe for water treatment and human consumption and because it can infect a wide variety of mammals (Figure 1) (39). Figure 1 would have more arrows, both unidirectional and bidirectional, if experiments had been conducted with all of the species or if it had been possible to confirm the source of oocysts in an outbreak.

There are three potential reservoirs of infection for both *Giardia* and *C. parvum*: wildlife, domestic livestock, and humans; outbreaks for both pathogens have been traced to all three sources. If the major concern is safe drinking water, appropriate control measures should be used to minimize risk from all three sources.

Studies to determine prevalence of these two pathogens have been conducted in many domestic species, including cattle, swine, sheep, horses, dogs, and cats. The National Animal Health Survey (19) is a recently completed national study that includes data on *Giardia* and *C. parvum* in beef and dairy animals. More than 7300 dairy calves on 1100 farms were sampled. The data showed that *C. parvum* oocysts were found on 55% of the dairy farms and in 22.4% of the tested heifers. Comparable data were obtained for beef calves. The percentage of dairy calves that were positive for cryptosporidiosis peaked when the calves were between 1 and 3 wk of age (43). Several studies have shown that few animals shed *C. parvum* oocysts after they are weaned or after they are 3 mo old. Quigley et al. (43) studied how colostrum feeding and housing affected prevalence of *C. parvum* and *Giardia* spp. in Jersey calves. The calves most likely to shed *C. parvum* were those that were housed in a barn rather than in hutches. Differences between nursing and bottle feeding of colostrum were not evident.

In addition to determining the prevalence of these protozoal pathogens, the National Animal Health Survey collected information on the relationship between management and infection (19). The management factor that had the most influence on the infec-
is not new: the Extension Service has been recommending that calves be kept clean for more than 75 yr. Now, there are new reasons to make and follow these time-tested, but often disregarded, recommendations about calf sanitation.

Other recommendations are common sense: young calves are the most likely animals in the herd to be infected with most of the pathogens included in this discussion; therefore, spreading their manure next to a water course is foolish. Runoff experiments with filter strips of varying widths and soil types have shown that a filter strip as narrow as 0.61 m can significantly reduce the risk of stream contamination (29). Soil type is important in determining microbial transport through soil (35). Identification of hydrologically active areas, where the risk of run-off is high, is a useful strategy in the development of a multiple barrier approach similar to that recommended by the Environmental Protection Agency. In these areas, manure spreading should be restricted both in terms of timing and in the source of the manure. Manure from mature cows can be spread on these areas only when the ground is not frozen and when the risk of run-off is low.

The duration of pathogen survival in different manure handling systems is an area in which additional research is needed. Although some Salmonella may survive for 286 d in slurry (52), this statistic is less important than the rate at which the population decreases. In many cases, 90% reduction of Salmonella occurs within a month. Describing how storage conditions affect survival is difficult because many variables, including the type of slurry, pH, dry matter content, storage temperature, number and type of pathogens present and storage strategy, all must be considered (52). Spore-forming organisms such as Clostridium perfringens and C. parvum oocysts are likely to be among the long-term survivors. Few pathogens can withstand the heat generated during composting, but ensuring that all parts of a compost pile reach and maintain a temperature of 60°C is important. Drying is an appropriate strategy in parts of the country where the sun shines frequently.

Most important in developing strategies to ensure the prosperity of dairy operations without damage to the environment is to involve farmers throughout the planning and implementation of projects. The suggestions made by Rossiter and Burhans (48) for the control of Mycobacterium paratuberculosis can easily be amended to deal with any of the pathogens found in manure.

As strategies are developed to minimize the threat posed by pathogens, it is important to remember some basic microbiology: microbial survival is limited by

**IMPLICATIONS**

Pathogenic microbes in manure must be considered to improve dairy management. Fortunately, many of the practices that reduce the prevalence of these organisms make economic sense as well: a herd is much better off without Johne’s disease. Much of the advice...
the following (50): sunlight, drying, freezing and thawing cycles, high temperatures, high or low pH, and, for some organisms, exposure to oxygen. Evaluation of the relative risks posed by different pathogens is difficult: farms with poorly fermented silage face a higher likelihood of L. monocytogenes infection than farms with well-preserved forages but not if animals are stressed because of inadequate housing. Assuming that a farm is free of one or all of the organisms considered in this paper is risky. A safer approach is to ensure 1) that cattle, particularly young stock, are kept clean and are well nourished; 2) that manure is stored and spread to minimize the risk of disease transmission; and 3) that appropriate environmental safeguards, such as filter strips, are used.

REFERENCES
SYMPOSIUM: MANURE MANAGEMENT


A MASSIVE OUTBREAK IN MILWAUKEE OF CRYPTOSPORIDIUM INFECTION TRANSMITTED THROUGH THE PUBLIC WATER SUPPLY

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M. Stephen Gradus, Ph.D., Kathleen A. Blair, M.S., R.N., Dan E. Peterson, M.D., M.P.H.,
James J. Kazmierczak, D.V.M., David G. Addiss, M.D., M.P.H., Kim R. Fox, P.E.,
Joan B. Rose, Ph.D., and Jeffrey P. Davis, M.D.

Abstract Background. Early in the spring of 1993 there was a widespread outbreak of acute watery diarrhea among the residents of Milwaukee.

Methods. We investigated the two Milwaukee water-treatment plants, gathered data from clinical laboratories on the results of tests for enteric pathogens, and examined ice made during the time of the outbreak for cryptosporidium oocysts. We surveyed residents with confirmed cryptosporidium infection and a sample of those with acute watery diarrhea consistent with cryptosporidium infection. To estimate the magnitude of the outbreak, we also conducted a survey using randomly selected telephone numbers in Milwaukee and four surrounding counties.

Results. There were marked increases in the turbidity of treated water at the city's southern water-treatment plant from March 23 until April 9, when the plant was shut down. Cryptosporidium oocysts were identified in water from ice made in southern Milwaukee during these weeks. The rates of isolation of other enteric pathogens remained stable, but there was more than a 100-fold increase in the rate of isolation of cryptosporidium. The median duration of illness was 9 days (range, 1 to 55). The median maximal number of stools per day was 12 (range, 1 to 90). Among 285 people surveyed who had laboratory-confirmed cryptosporidiosis, the clinical manifestations included watery diarrhea (in 93 percent), abdominal cramps (in 84 percent), fever (in 57 percent), and vomiting (in 48 percent). We estimate that 400,000 people had watery diarrhea attributable to this outbreak.

Conclusions. This massive outbreak of watery diarrhea was caused by cryptosporidium oocysts that passed through the filtration system of one of the city's water-treatment plants. Water-quality standards and the testing of patients for cryptosporidium were not adequate to detect this outbreak. (N Engl J Med 1994;331:161-71.)

HUMAN infection with cryptosporidium was first documented in 1976.1 2 Since that time, cryptosporidium has been recognized as a cause of gastrointestinal illness in both immunocompetent3-4 and immunodeficient people.5 6 Infection with cryptosporidium results in watery diarrhea associated with varying frequencies of abdominal cramping, nausea, vomiting, and fever. In immunocompetent people, cryptosporidium is a self-limited illness, but those who are immunocompromised, infection can be relapsing and fatal.7 8 Infection occurs in a variety of settings:9 10 waterborne outbreaks of cryptosporidium infection have been documented in association with drinking water from a contaminated artesian well,11 untreated surface water,12 and filtered public water supplies.13-16 We report our investigation of the largest documented outbreak of waterborne disease in the United States.

On April 5, 1993, the Wisconsin Division of Health was contacted by the Milwaukee Department of Health after reports of numerous cases of gastrointestinal illness that had resulted in widespread absenteeism among hospital employees, students, and schoolteachers. Little information was available about the nature of the illness or the results of laboratory tests of stool specimens from those who were ill. On April 7, two laboratories identified cryptosporidium oocysts in stool samples from seven adult residents of the Milwaukee area; none of the laboratories surveyed had found evidence of increased or unusual patterns of isolation of any other enteric pathogen.

The Milwaukee Water Works (MWW), which obtains water from Lake Michigan, supplies treated water to residences and businesses in the City of Milwaukee and nine surrounding municipalities in Milwaukee County. Either of two water-treatment plants, one located in the northern part of the city, and the other in the southern part, can supply water to the entire district; however, when both plants are in operation, the southern plant predominately serves the southern portion of the district.

Examination of the two plants' records on the quality of untreated water (intake) and treated water (that supplied to customers) revealed an increase in the turbidity of treated water from the southern plant, beginning approximately on March 21, with increases to unprecedented levels of turbidity from March 23 through April 5. These findings pointed to the water supply as the likely source of infection and led to the institution, on the evening of April 7, of an advisory to MWW customers to boil their water. The southern plant was temporarily closed on April 9.

Methods

Investigation of Water-Treatment Plants

The policies, procedures, and physical plant of the southern MWW facility were reviewed and inspected in April 1993. Data on the monthly maximal turbidity of untreated and treated water from both plants were reviewed and analyzed for the period from January 1983 through April 1993. Data on the daily maximal turbidity and
NTU or higher, with peaks of 1.7 NTU on March 28 and 30, despite an adjustment of the dose of polyalumimum chloride (Fig. 1). Although marked improvement in the turbidity of treated water had been achieved by April 1 with the use of polyaluminum chloride, on April 2 the southern plant began to use alum instead of polyaluminum chloride as a coagulant. On April 5, the turbidity of treated water increased to 1.5 NTU. During the period from February through April 1993, the turbidity of treated water at the northern plant did not exceed 0.45 NTU. There was no correlation between the turbidity of treated water and the turbidity or temperature of untreated water.

Throughout the period from February to April 1993, samples of treated water from both plants were negative for coliforms and were within the limits set by the Wisconsin Department of Natural Resources for water quality. Inspection of the southern plant revealed that a streaming-current monitor, which can aid plant operators in adjusting the dose of coagulant, had been incorrectly installed and thus was not in use. In addition, monitors designed for continuous measurement of the turbidity of filtered water were not in operation. Turbidity was monitored once every eight hours.

**Examination of Ice Made during the Outbreak**

Water obtained by melting ice blocks produced on March 25 and April 9, 1993, contained cryptosporidium in concentrations of 13.2 and 6.7 oocysts per 100 liters, respectively, when filtered through a membrane filter with an absolute porosity of 0.45 μm and 2.6 and 0.7 oocysts per 100 liters, respectively, when filtered through a polypropylene cartridge filter with a nominal porosity of 1 μm.

**Laboratory Surveillance**

During the period from March 1 through April 16, 1993, a total of 2300 stool specimens were submitted to the 14 clinical laboratories in the Milwaukee vicinity for routine culture for bacterial enteric pathogens. Twenty specimens (0.9 percent) were positive for salmonella, 10 (0.4 percent) for shigella, and 11 (0.5 percent) for campylobacter; 1 of 80 specimens (1.2 percent) cultured for yersinia and 1 of 73 (1.4 percent) cultured for aeromonas were positive. During the same period, 1 of 1724 stool specimens examined for ova and parasites (0.8 percent) were found to have giardia, and 5 of 266 specimens cultured for enteric viruses (2 percent) were positive. An enzyme immunosassay kit for rotavirus was used to test 96 specimens, 3 of which (3 percent) were positive. From March 1 through April 6, 12 of 42 stool specimens (29 percent) tested for cryptosporidium were positive; from April 8 through April 16, 331 of 1009 specimens (33 percent) were positive. We found no evidence of cyclospora infection. Oocysts examined by the Centers for Disease Control and Prevention were 4 to 6 μm in diameter and were positive for cryptosporidium with monoclonal-antibody staining.

**Examination for Enteric Infection**

Cryptosporidium was identified in stool specimens from 8 of the 11 people with gastrointestinal illness (73 percent) whose specimens were obtained within 48 hours after the onset of illness. Stool cultures for enteric bacterial and viral pathogens, electron microscopical studies, and stool examination for other ova and parasites, including cyclospora and microsporidia, were negative. None of the pairs of serum samples (obtained during the acute and convalescent phases of illness) had a fourfold rise in antibody to the Norwalk virus.

**Laboratory-Confirmed Cryptosporidium Infection**

Of the 285 patients with laboratory-confirmed cryptosporidium infection, 170 (60 percent) were female, 130 (46 percent) were hospitalized during the course of their illness, and 48 (17 percent) were immunocompromised; their mean age was 41 years (range, 2 months to 93 years). All 285 patients had diarrhea, and 265 (93 percent) characterized it as watery (Table 1). The median duration of diarrhea was 9 days (range, 1 to 55), with a median reported maximum of 12 stools per day (range, 1 to 90). Among people with fever, the median reported maximum temperature was 38.3°C (101°F) (range, 37.2 to 40.5°C [99 to 105°F]). The date of the onset of illness was available for 254 confirmed cases with an onset during the period from March 1 through April 15 (Fig. 2, upper panel).

Of the 200 patients with laboratory-confirmed infection who were interviewed with the longer questionnaire, 150 (75 percent) reported weight loss, with a median loss of 4.5 kg (10 lb) (range, 0.45 to 18 kg [1 to 40 lb]), and 81 (41 percent) were hospitalized with cryptosporidium infection for a median of 5 days (range, 1 to 55). Seventy-seven patients (39 percent)
terborne outbreak could have been expected during March and April 1993 (unpublished data). Thus, an estimated 400,000 people had watery diarrhea that could be attributed to this outbreak.

**Discussion**

A massive outbreak of waterborne cryptosporidium infection occurred in the greater Milwaukee area during late March and early April 1993. We estimate that more than 400,000 people were affected during this outbreak; however, by limiting the case definition to watery diarrhea in our survey, we may have underestimated the size of the affected population. Cryptosporidium infection was confirmed in more than 600 people with gastrointestinal illness in association with this outbreak, and despite intensive investigation, no other enteric pathogen could be found to account for the illness.

More than half the people who received residential drinking water predominantly from the MWW's southern water-treatment plant became ill, which was twice the rate of illness among people whose initial drinking water came mainly from the MWW's northern water-treatment plant. The intermediate attack rate among residents of the middle zone was expected, since the MWW distribution system, adjusting for variations in flow, would have intermittently allowed water from the southern plant to reach their residences. Diarrhea among people not living in the MWW service area may have resulted from consumption of water while they were working in or visiting the area. Among nursing home residents in the northern region, who were unlikely to travel, there was no increase in diarrheal illness associated with the outbreak.

**Table 2. Rate of Watery Diarrhea from March 1 through April 28, 1993, among Respondents in a Random-Digit Telephone Survey of Households in the Greater Milwaukee Area, According to Sex, Age, and Water Works Region.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of Respondents</th>
<th>No. Reporting Watery Diarrhea</th>
<th>Attack Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1663</td>
<td>436</td>
<td>26</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>783</td>
<td>195</td>
<td>25</td>
</tr>
<tr>
<td>Female</td>
<td>877</td>
<td>243</td>
<td>28</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Age (yr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>225</td>
<td>49</td>
<td>19</td>
</tr>
<tr>
<td>10-19</td>
<td>240</td>
<td>63</td>
<td>26</td>
</tr>
<tr>
<td>20-29</td>
<td>302</td>
<td>61</td>
<td>20</td>
</tr>
<tr>
<td>30-39</td>
<td>308</td>
<td>104</td>
<td>34</td>
</tr>
<tr>
<td>40-49</td>
<td>228</td>
<td>74</td>
<td>33</td>
</tr>
<tr>
<td>50-59</td>
<td>149</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>60-69</td>
<td>106</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>≥70</td>
<td>155</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Unknown</td>
<td>20</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Water Works region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWW</td>
<td>790</td>
<td>309</td>
<td>39</td>
</tr>
<tr>
<td>Southern</td>
<td>359</td>
<td>186</td>
<td>52</td>
</tr>
<tr>
<td>Middle zone</td>
<td>129</td>
<td>42</td>
<td>33</td>
</tr>
<tr>
<td>Northern</td>
<td>317</td>
<td>81</td>
<td>26</td>
</tr>
<tr>
<td>Non-MWW</td>
<td>873</td>
<td>127</td>
<td>15</td>
</tr>
</tbody>
</table>
and outbreaks are likely to be underrecognized. Our findings have implications for standards of water quality, public health surveillance, and recognition of cryptosporidiosis outbreaks in the United States. Until an inexpensive, rapid, and sensitive means of detecting and quantifying cryptosporidium in treated water is available, we believe that water-treatment plants should consider instituting continuous monitoring of treated water for turbidity, particularly of filter effluent and particle size. Plant design and water-treatment procedures should be improved to maintain the quality of treated water at a level that will make the presence of oocysts unlikely (e.g., a goal of turbidity ≤ 0 NTU). We recommend that clinicians and laboratories consider performing routine stool tests for cryptosporidium in people with watery diarrhea and that public health officials make cryptosporidium infection a reportable condition. In the United Kingdom, water and health officials have already developed an extensive strategy to investigate the clinical importance of cryptosporidium found in water supplies. Intensive efforts and cooperation between the medical community and those who provide and regulate drinking water in the United States will be required to prevent future waterborne outbreaks caused by this emerging pathogen and ensure the safety of drinking water for all citizens.

We are indebted to the following people for their contributions to this study: Walter Powers, A.J. Henry, and Richard R. Regent, Milwaukee Water Works, the infection-control practitioners at participating nursing homes and hospitals in the Milwaukee area; the directors and parasitologists at the 14 participating clinical laboratories in the Milwaukee vicinity; Hon. John Norton, mayor of the City of Milwaukee; Paul Nannis, director, Thomas Schlenker, M.D., and the staff of public health nurses and administrators at Milwaukee Health Department; Robert H. Sebela, M.A., Helen Novich, R.N., Jack Wolski, R.N., John Chapin, Ivan Imm, and John Boczko, Wisconsin Division of Health; Ron Tursky and the staff of the Milwaukee STD Program; Carol Graham, R.N., and the volunteer public health nurses of the Greater Milwaukee area; Gerald Sedmak, Ph.D., Ajith Singh, Ph.D., and the staff of the Milwaukee Bureau of Laboratories; Paul Birdy, director of the Division of Environmental Health Section, Milwaukee Health Department; Dennis Jurack, D.V.M., Division of Parasitic Diseases, Center for Infectious Diseases; Roger Glass, M.D., M.P.H., Ph.D., Stephen S. Monroe, Ph.D., Charles Humphries, Ph.D., and Sara Prieur, Centers for Disease Control and Prevention (CDC) Viral Gastroenterology Laboratory; Margarette Hurd and the staff of the CIVIC Parasitology Laboratory; the staff of the Wisconsin State Laboratory of Hygiene, staff of the Survey Research Laboratory, University of Wisconsin Extension, Darren Lytle, Ph.D., Environmental Protection Agency; and Ava Navin, Epidemiology Program Office, CDC.

REFERENCES

Cryptosporidiosis-Associated Mortality Following a Massive Waterborne Outbreak in Milwaukee, Wisconsin

Neil J. Hoxie, MS, Jeffrey P. Davis, MD, James M. Vergeroni, MD, Raymond D. Nashold, PhD, and Kathleen A. Blair, MS, RN

Abstract

Introduction

During March and April 1993, a massive, waterborne outbreak of cryptosporidiosis occurred among residents of and visitors to Milwaukee, Wis. In Milwaukee, water obtained from Lake Michigan is chlorinated and filtered at one of two Milwaukee Water Works plants before entering the water distribution system. The source of this outbreak was Lake Michigan water contaminated with Cryptosporidium oocysts. This contamination was not adequately removed at one of the Milwaukee water treatment facilities, allowing Cryptosporidium oocysts to enter the drinking water supply. It is estimated that 403,000 residents living in a five-county area and numerous visitors to the city of Milwaukee experienced watery diarrhea during this outbreak.1,2

Cryptosporidiosis is characterized by watery diarrhea, often with abdominal cramping, nausea, vomiting, and fever.3 In otherwise healthy persons, the infection and disease are usually self-limited, in immunocompromised hosts, however, Cryptosporidium infection can be unrelenting and fatal.4 Understanding the potential for fatal outcomes associated with waterborne cryptosporidiosis outbreaks needs to be an important part of discussions about preventing such outbreaks. This report presents results of an analysis of death certificate data to provide an estimate of cryptosporidiosis-associated mortality during the 2 years following the massive waterborne outbreak of Cryptosporidium infection in Milwaukee.

Methods

Wisconsin death certificate data obtained from the Center for Health Statistics, Wisconsin Division of Health, were analyzed for April 1, 1990, through March 31, 1993. The Milwaukee waterborne cryptosporidiosis outbreak began in mid- to late March 1993.1 For the purposes of this report, March 15, 1993, is defined as the beginning of the interval of the waterborne Cryptosporidium exposure that led to the Milwaukee outbreak. The overall study period encompasses approximately 2-year intervals before and after the beginning of the exposure interval. The preexposure period is defined as April 1, 1991, through March 14, 1993; the postexposure period is defined as March 15, 1993, through March 31, 1995.

The Milwaukee Water Works supplies water to 800,000 residents of the city of Milwaukee and 10 other municipalities in Milwaukee County. In addition, residents of communities within Milwaukee County and the four surrounding counties by the Milwaukee Water Works, have frequent opportunities to consume water treated by the water works while working in, or visiting, areas supplied by it. For this reason, mortality estimates were derived for decedents whose death certificate specified residency in a five-county Milwaukee vicinity. The Milwaukee vicinity is defined as Milwaukee, Ozaukee, Racine, Washington, and Waukesha counties.

Wisconsin death certificates list the International Classification of Diseases, 9th revision, clinical modification (ICD-9-CM) code for the underlying cause of death and up to 20 contributing causes.6 Cryptosporidiosis is coded with the code for coccidiosis, ICD-9-CM 007.2, which is also used for infections by the genus Isospora. Any death that had ICD-9-CM 007.2 recorded as the underlying or a contributing cause of death on the death certificate is defined as cryptosporidiosis associated. In this study, an acquired immunodeficiency syndrome (AIDS) death is defined as any death that had AIDS (ICD-9-CM 427.0 through 427.9), but not cryptosporidiosis associated.
Results

From April 1, 1991, through March 31, 1994, 58 cryptosporidiosis-associated deaths occurred among residents of the Milwaukee vicinity. 4 occurred during the preoutbreak period, and 54 occurred during the postexposure period (Figure 1). During the same period, 10 cryptosporidiosis-associated deaths occurred among Wisconsin residents outside the Milwaukee vicinity; 4 occurred during the preexposure period, and 6 occurred during the postexposure period (Figure 1).

Among Milwaukee vicinity postoutbreak cryptosporidiosis-associated deaths, cryptosporidiosis (ICD-9-CM 007.2) was recorded as the underlying cause of death for 94% of the residents, and cryptosporidiosis was recorded as a contributing cause for the remaining 16% (Table 1). AIDS was the underlying cause of death for 85% of postoutbreak cryptosporidiosis-associated deaths among residents of the Milwaukee vicinity. The demographic characteristics of the postoutbreak cryptosporidiosis-associated deaths among residents of the Milwaukee vicinity (Table 2) are consistent with those of persons with AIDS in this area.

During the 3 years prior to the outbreak (April 1990 through March 1993), there was a linear increase in the number of AIDS deaths among residents of the Milwaukee vicinity ($r^2 = .88$, Figure 2). If we extrapolate this trend through the postoutbreak period, the number of AIDS deaths predicted during each 6-month interval could be 59 (95% confidence interval [CI] 52, 66) during April through September 1993; 63 (95% CI = 54, 72) during October 1993 through March 1994; 66 (95% CI = 56, 77) during April through September 1994; and 70 (95% CI = 58, 82) during October 1994 through March 1995.

Among residents of the Milwaukee vicinity, 78 AIDS deaths were identified during the first 6-month postoutbreak interval (April through September 1993)—19 (95% CI = 12, 26) more than predicted from the preoutbreak trend (Figure 2). During the next two 6-month intervals (April through September 1993 and October 1993 through March 1994), the number of AIDS deaths identified (48 and 46, respectively) was significantly lower than predicted. During the last 6-month interval analyzed (October 1994 through March 1995), the 64 AIDS deaths identified were not significantly different from what was predicted by the preoutbreak trend.

Discussion

This analysis indicates that among residents of the Milwaukee vicinity, the number of cryptosporidiosis-associated deaths increased markedly following the waterborne outbreak. Fifty-four cryptosporidiosis-associated deaths occurred during the 2-year postoutbreak period compared with 4 in the 2 years before the outbreak. This represents more than a 13-fold increase in cryptosporidiosis-associated mortality. If, in this population, 4 cryptosporidiosis-associated deaths in 2 years are expected under typical circumstances, then during the 2 years following the outbreak, an additional 50 cryptosporidiosis-associated deaths occurred.

This estimate should be interpreted with caution for several reasons. Death cen-

<table>
<thead>
<tr>
<th>Underlying Cause of Death</th>
<th>ICD-9-CM Code</th>
<th>No. of Deaths</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIDS</td>
<td>042.0-044.9</td>
<td>45</td>
<td>85</td>
</tr>
<tr>
<td>Coccioides</td>
<td>007.2</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Unspecified viral hepatitis</td>
<td>70.9</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Neoplasm of the brain</td>
<td>239.6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Heart failure, unspecified</td>
<td>426.9</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Alcoholic cirrhosis of the liver</td>
<td>571.2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

![FIGURE 1 - Cryptosporidiosis-associated deaths among Wisconsin residents of (a) the 5-county Milwaukee vicinity (n = 58) and (b) the 67 counties outside the Milwaukee vicinity (n = 10), by month of death: April 1, 1991, through March 31, 1991.](image-url)
TABLE 2—Demographic Characteristics of Cryptosporidiosis-Associated Deaths (n = 54) among Residents of the Milwaukee Vicinity, March 18, 1993, through March 31, 1995

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of Deaths</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>49</td>
<td>91</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>41</td>
<td>76</td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>County of residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milwaukee</td>
<td>47</td>
<td>87</td>
</tr>
<tr>
<td>Racine</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Waukesha</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: Median age at death was 35 years (range, 1–69 years).

Subsequent increased likelihood that cryptosporidiosis would be listed as a cause of death. If this happened, some of the apparent increase in postepidemic mortality could have resulted from increased awareness and thus not represent a true increase in occurrence. While this possibility should be considered, the effect, if any, that this factor had on the mortality estimates cannot be determined from these data.

Another consideration is whether cryptosporidiosis-associated mortality was under-reported on death certificates. We analyzed AIDS mortality trends among residents of the Milwaukee vicinicity who did not have cryptosporidiosis recorded on their death certificates, and we noted a significant increase in AIDS mortality during the first month after the outbreak, followed by a 6-month interval with lower-than-expected AIDS mortality, and then a return to expected levels. This pattern is consistent with the presence of an AIDS epidemic among persons who would have otherwise died later. These observations suggest that the presence of an AIDS epidemic associated with the outbreak and that, at least among persons with AIDS, cryptosporidiosis as a cause of death was under-reported on death certificates during the postepidemic period.

Estimates of cryptosporidiosis-associated mortality based on death certificate reporting alone should, therefore, be regarded as minimum estimates. It is very likely that additional cryptosporidiosis-related deaths occurred after this outbreak, however, a more precise estimation of the number of additional deaths would require additional studies.

The Milwaukee cryptosporidiosis outbreak was the largest outbreak of waterborne disease ever reported in the United States. Our analysis indicates that this outbreak was associated with a substantial number of deaths, particularly in immuno-compromised populations. The Milwaukee population is not unique in its susceptibility to the severe consequences of a waterborne cryptosporidiosis outbreak. In many other metropolitan areas in the United States, the immuno-compromised population is considerably larger than in Milwaukee. Indeed, in 1992, just prior to the outbreak, the annual reported AIDS case rate in the Milwaukee metropolitan area ranked 75th among the case rates of 98 metropolitan areas in the United States with populations of 500,000 or more.13

Cryptosporidium contamination of surface water is quite common. Studies indicate that Cryptosporidium oocysts are present in 67% to 97% of surface waters tested throughout the United States.14 Furthermore, the number of ingested Cryptosporidium oocysts required to cause illness is quite low. A recent report noted that the median human infective dose could be as low as 132 oocysts.15 The ubiquitous nature of this protozoan in surface water, its high infectivity, and the large number of individuals at risk of severe disease underscore the potential for fatal outcomes associated with waterborne Cryptosporidium outbreaks such as occurred in Milwaukee. To prevent future loss of life from waterborne Cryptosporidium outbreaks, it is essential to ensure that all persons have access to safe drinking water.16

FIGURE 2—AIDS deaths, excluding cryptosporidiosis-associated deaths, among residents of the Milwaukee vicinicity, by 6-month interval, and projected linear trend based on deaths from April 1990 through March 1993.
Predisposing Factors for Individuals’ Lyme Disease Prevention Practices: Connecticut, Maine, and Montana

James E. Herrington, Jr. MPH, CHES, Grant L. Campbell, MD, PhD.
Raymond E. Bailey, MS, Matthew L. Carter, MD, MPH, Mary Adams, MPH.
Emma L. Frazier, PhD, Todd A. Damrow, PhD, and Kathleen F. Gensheimer, MD, MPH

Introduction

Lyme disease is caused by infection with the spirochete Borrelia burgdorferi, acquired from the bite of an infective Ixodes scapularis tick in the northeastern and upper midwestern United States or Ixodes pacificus in the West. First described in 1977 as a chronic arthritis among children living in Connecticut, Lyme disease has become an important emerging infectious disease over the past decade, accounting for more than 90% of all reported cases of vector-borne illness in the United States. In 1996, 16,461 cases of Lyme disease were reported to the Centers for Disease Control and Prevention (CDC) by 45 state health departments. The overall trend has been an average 15% annual increase in reported cases since 1991, when all 50 states adopted the national Lyme disease case surveillance definition. Although considerable knowledge of the biology and ecology of Lyme disease has been accumulated, the prevalence of behavioral risk factors for Lyme disease has not been well defined. No studies have systematically investigated the factors that motivate individuals to take health-directed personal protective measures against Lyme disease.

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This paper was accepted February 20, 1997.
United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825

IN REPLY REFER TO:
1-1-00-TA-2158

September 14, 2001

Mr. Bill Zumwalt
Kings County Planning Department
Government Center Building #6
1400 W. Lacey Boulevard
Hanford, CA 93230

Subject: Comments on the Revised Program Environmental Impact Report for the Draft Dairy Element of the Kings County General Plan

Dear Mr. Zumwalt:

This letter responds to the Revised Program Environmental Impact Report for the Draft Dairy Element of the Kings County General Plan SCH #2000111133 (PEIR), dated May 7, 2001, that was received by the U.S. Fish and Wildlife Service (Service) on May 10, 2001. The PEIR presents goals, objectives, and policies to guide development, expansion, and operation of milk cow dairies in the Kings County. Three hundred and ninety-four square miles have been designated as suitable for the development and expansion of bovine dairy facilities and 646 square miles have been designated as suitable for reuse of manure and process water generated at dairies as fertilizer and irrigation on cropland. Because the implementation of this project will likely impact federally-listed species, we are providing comments and recommendations pursuant to our responsibilities under the Endangered Species Act of 1973, as amended (Act). We previously provided comments to Kings County on this issue in a letter to the Kings County Planning Department dated February 15, 2001.

As a Responsible Agency under the California Environmental Quality Act, the County of Kings has a responsibility to ensure that potential project impacts are identified, alternatives are considered, and potential impacts are avoided and/or mitigated to below a level of significance. This responsibility includes ensuring that the impacts of the project, considered together with the past, present, and reasonably foreseeable impacts of other projects, will not result in cumulative impacts to the extent that such impacts significantly affect the quality of the environment. The concentration of proposed and current concentrated animal feeding operations (CAFOs) in this area could pose a number of risks to water quality and public health, mainly owing to the amount of animal manure and wastewater they generate. Manure and wastewater from large, CAFOs have the potential to contribute pollutants such as nutrients (e.g., nitrogen, phosphorus), organic matter, dust, carbon dioxide, methane, sediments, pathogens, heavy metals, hormones, antibiotics, and ammonia to the environment. These pollutants can cause several types of water quality,
public health, and other environmental impacts, including the contamination of drinking water supplies, soil contamination, air pollution, vegetation loss, algal blooms, fish kills, ground water depletion, endocrine disruption and animal deformities (e.g., amphibians and birds), and the creation of suitable conditions for vectors of diseases.

Section 9 of the Act prohibits the “take” (e.g., hunt, harm, harass, pursue, injure, kill, trap, wound, collect) of federally listed wildlife species. “Harm” is further defined to include habitat modification or degradation that kills or injures wildlife by impairing essential behavioral patterns including breeding, feeding, or sheltering (50 CFR § 17.3). Congress established two provisions (sections 7 and 10) of the Act that allow for the “incidental take” of listed species by Federal agencies, private interests, and non-Federal government agencies. Incidental take is defined as take that is “...incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.” Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of a formal consultation between that agency and the Service pursuant to section 7 is required if it is determined that the proposed project may affect a federally listed species. Such consultation may result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a proposed project does not involve a Federal agency, but is likely to result in the take of a listed animal species, then the landowner or project proponent should apply for an incidental take permit, pursuant to section 10. When an application is made for an incidental take permit, measures to avoid, minimize, or mitigate for effects to listed species and their habitat must be identified and incorporated into a habitat conservation plan. If the habitat conservation plan and the application for the permit meet the issuance criteria, a permit authorizing incidental take may be issued by the Service.

We appreciate the removal of the word “native” from policy 3.3a of the Dairy Element, as requested in our February 15, 2001, letter to your agency. However, we remain concerned about the following issues:

1. **Wildlife Survey requirement for the Technical Report**: The Technical Report is a report prepared by a qualified professional that is submitted with an application for a new dairy or expansion of an existing dairy. Before construction begins, the applicant should obtain concurrence from the Service that their proposed project is in compliance with the Act. We recommend that this be included as a required component of the Wildlife Habitat Survey for the Technical Report.

2. **Potential effects of the proposed development expansion and/or operation on vernal pool species, including the federally-listed vernal pool tadpole shrimp (Lepidurus packardi) and the vernal pool fairy shrimp (Branchinecta lynchi)**: From maps in the PEIR, it appears that the implementation of this project may result in loss or degradation of vernal pools and other wetlands. Federally-listed vernal pool crustaceans, have been documented at several locations in Kings County. Although wetlands are discussed in the PEIR, vernal pools, and more specifically, vernal pool crustaceans, should be adequately addressed in the final environmental documents.
3. Effects of the proposed project on the San Joaquin kit fox (*Vulpes macrotis mutica*; "kit fox"): Kit foxes are known to forage in agricultural fields and use them as travel corridors. Although farmland is not used as intensely as natural lands by foraging or traveling kit foxes, it is becoming more important as foraging areas and travel corridors as natural lands are eliminated by land conversions. The proposed dairy facilities and intensified cultivation pattern will greatly reduce in value or permanently remove agricultural lands from possible use by the kit fox for foraging and other essential behaviors. Therefore, the development of dairy structures on former croplands could constitute harm to the kit fox because these areas can no longer be used for activities such as foraging, dispersal, and denning; all of which strongly influence the survival of kit foxes. Hence, we do not agree with the PEIR that the proposed project will not adversely impact the San Joaquin Kit Fox.

Additionally, we have the following comments and concerns regarding contaminants issues:

**Specific Concerns Relevant to Dairies and the PEIR**

The US Food and Drug Administration’s (FDA) September, 1993, *Federal Register* announcement noted that selenium concentrations in a few sampled dairy cow manure pits had been documented at levels of 63-88 micrograms/liter (parts per billion). By comparison, the U.S. Environmental Protection Agency’s (EPA) selenium water quality criterion for protection of aquatic life is 5 micrograms/liter, and EPA’s human drinking water standard for selenium is 50 micrograms/liter. Thus, direct contamination of fish and wildlife habitats and human drinking water supplies is clearly a potential hazard that the PEIR should address. The FDA also noted that without more information on the exact chemical forms of selenium in dairy manure, potential for environmental impact cannot be evaluated adequately to support a Finding of No Significant Impact (FONSI) pursuant to the National Environmental Policy Act (NEPA). Of equal or greater concern, is the issue of selenium loading into the environment via land applications of dairy manure. As FDA stated (1993:47968), “Agricultural soils are highly manipulated oxidized systems that tend to favor formation of selenite and selenate and stimulate microbial activities.” Much previous research has revealed that selenate selenium is highly mobile in the environment, easily transported to aquatic ecosystems, where it can rapidly become bioaccumulated to toxic levels (e.g., papers in Frankenberger and Engberg 1998).

The Council for Agricultural Science and Technology (CAST) recently (1994) published some vital statistics regarding selenium dynamics of lactating Holstein cows. For a herd receiving feed supplemented with 0.3 ppm selenium, it was found that on average each cow excreted 6.4 milligrams selenium (in urine and manure) per day (CAST 1994:13). That works out to the equivalent of 1.668 grams Selenium/yr/animal unit (AU), assuming that a lactating Holstein cow equals 1.4 AU (as assumed in the PEIR) and that there are 365 days in a year. Thus, if the entire remaining capacity of 586,207 AU recognized in the draft Dairy Element were fulfilled, it would result in about an additional 978,000 grams selenium being introduced into the Kings County environment each year. This roughly 1 million grams of additional environmental selenium is far from trivial. That is the equivalent of an annual addition of 1 trillion micrograms of selenium to the environment, and remember that as little of 6 micrograms in a liter of water would be considered an environmentally toxic amount by U.S. EPA. We recommend the final
environmental documents contain an adequate analysis of the projected environmental fate of those trillions and trillions of micrograms of selenium that will be introduced into the environment if the draft Dairy Element is fully implemented as proposed. The FDA has clearly warned the public that supplementing livestock feeds with 0.3 ppm selenium is a significant issue.

Selenium in Perspective

The overall implications of adding 586,207 AU to the existing dairy herds (283,974 AU) in Kings County and spreading manure from all 870,181 AU’s over the 665,623 acres (269,483 hectares) of the dairy development and nutrient spreading zones is equivalent to an expectation of adding 5.5 grams of selenium per hectare per year to the manured lands (if selenium supplementation of feed is ubiquitous and if manure wastes are spread absolutely evenly across the available 269,483 hectares). This estimate could be low, if the cows are being fed poultry litter. FDA does not regulate total selenium content of livestock feeds, but only the supplemental addition of inorganic selenium salts. In poultry production areas, such as Kings County, it is not uncommon to use poultry litter (wastes) as a feed for cows. Such litter has been documented to contain an average of about 1 ppm selenium, which would be in addition to the selenium fortification of more traditional sources of feed. Thus, the estimate of 5.5 grams of selenium per hectare per year from cow manure could be low. FDA constructed a model to evaluate the addition of 3.94 grams of selenium per hectare via application of chicken manure and calculated that such a scenario would lead to surface runoff from the amended fields that contained 7.8 micrograms/liter of selenium, or 1.56 times U.S. EPA’s aquatic life criterion. FDA’s model did not consider the cumulative effects of repeated annual additions of selenium to the environment, but only looked at the scenario of a one-time land application of manure. If the FDA modeling even remotely applies to Kings County conditions, the environmental consequences of increasing Kings County dairy herds (including support stock) by 586,207 AU would be potentially significant for any surface water feature downslope of manured lands and all listed species of animals strongly linked to aquatic ecosystems.

Additional perspective, or context, can be gained from a study of Stewart Lake, Utah (Stephens et al. 1992), where it was found that annual loading of only 252 grams of selenium (to the 250 surface-acre lake) was sufficient to cause selenium bioaccumulation in waterfowl eggs of over 20 parts per million (an unequivocally toxic dose that caused embryo deformities). Thus, with an addition of only 2.5 grams of selenium per surface hectare of the lake, severe selenium poisoning of wildlife occurred.

A study by Gissel-Nielsen (1973) monitored the environmental effects of a 120 gram per hectare selenium amendment. It was found that the selenium content of earthworms increased from 2.2 parts per million to 7.5 parts per million. Generally, about 5 parts per million Se (or more) in earthworms would present a toxic hazard to vertebrate animals (such as robins) that eat earthworms. Under the full herd development scenario for the Kings County draft Dairy Element, a cumulative application of 120 grams of selenium would be reached in about 20-25 years.

In conclusion, it seems quite plausible that 5.5 grams of selenium applied per hectare per year is more than the environment of Kings County could safely withstand. This suggests that addition
of nitrogen and/or salts may not be the limiting constraint on herd size that was assumed by the Kings County Planning Agency and therefore that the calculations of allowable total herd sizes for Kings County should be reexamined in the final environmental documents.

Uncertainties and Monitoring

There are numerous, and important uncertainties associated with analyses such as those presented above (as elaborately presented in FDA's September, 1993, Federal Register announcement) such that educated predictions about reality are virtually impossible (as opposed to specific hypothetical scenarios, that are very precise, but of unknown realism). The known potentials for grave risk, however, are well documented; yet the PEIR does not prescribe any selenium monitoring. Adding selenium to the minimum monitoring requirements is mandatory for risk management given the well known scientific uncertainties. The PEIR also did not prescribe monitoring of any kind for lands receiving applications of dairy manure, nor any monitoring of downslope surface aquatic features.

Other Unaddressed Contaminant Issues

In addition to selenium supplementation of livestock feeds, supplementation with antibiotics, growth promoters, and other nontraditional contaminants is also common practice. The PEIR needs to address the issue of potential environmental release of such constituents and needs to evaluate the potential for hazard. The final environmental documents should address the expected loading to the environment of such constituents and how sensitive such loadings will be to the environment. If the project is approved as proposed, massive tonnages of medicated and otherwise chemically manipulated feed will be converted to massive tonnages of liquid and solid dairy waste (manure) that will be released to the environment on a grand spatial scale (665,623 acres). The environmental consequences at the landscape level is unaddressed in the PEIR for most of the known contaminants in livestock feed/manure. Therefore, we recommend the County of Kings adequately address these issues.

The copper and zinc content of dairy manure are not adequately addressed in the PEIR. Other manures, such as poultry and swine manure contain concentrations of copper and zinc that quickly present a cumulative hazard if the manure is repeatedly applied to the same piece of land. Many livestock feeds are fortified with copper and zinc, two metals that tend to cumulatively accumulate in soils subject to repeated manure applications. Phytotoxicity from land applications of copper and zinc rich manures, and permanent chemical sterilization of agricultural lands are issues of serious concern (e.g., Warrick and Stith 1995). The final environmental documents should compare metals composition of dairy manure to regulatory lifetime loading limits for such metals as stipulated for land application of sewage sludges. For sewage sludges, once the lifetime loading limit is exceeded for any one metal, further land application of sludge is permanently forbidden. There is no adequate discussion of such concepts and environmental safeguards with respect to the massive land applications of dairy manure that will be a necessary part of the draft Dairy Element.
Groundwater Protection

A principal component of the groundwater protection strategy in the PEIR is the prohibition of dairy development where shallow groundwater is within 5 feet of the surface. However, shallow groundwater levels across much of Kings County are not static. For example, the California Department of Water Resources (DWR) reported that within the “Tulare Sub-Basin” (almost exclusively Kings County) the amount of land with shallow groundwater within 5 feet of the surface had increased from 119,000 acres in 1991 to 301,000 acres in 1997 (DWR 1997). The rapidly changing status of groundwater levels in Kings County must be taken into consideration. To treat groundwater levels as static, will likely result in many dairies being sited over shallow groundwater despite the prohibition of that in the PEIR. The final environmental documents should adequately discuss what will be done if groundwater rises to within 5 feet of the surface after a dairy has been approved and developed. The final environmental documents also should adequately address monitoring the dynamics of shallow groundwater after a dairy has been approved and developed.

Comparison of the 1997 DWR groundwater maps with the PEIR maps for proposed Dairy Development Overlay Zones (DDOZ) and Nutrient Spreading Overlay Zones (NSOZ) reveals very substantial overlap. The final environmental documents should discuss why dairy development is being proposed for substantial areas of land that already have shallow groundwater within 5 feet of the surface. An even larger proportion of the proposed NSOZ area already has shallow groundwater within 5 feet of the surface. The final environmental documents should adequately discuss the proposal to use large areas of land with shallow groundwater for manure applications. Based on the DWR (1997) groundwater maps, it certainly appears as though the amount of land deemed suitable for the DDOZ is substantially overestimated due to conflict with the draft Dairy Element prohibition against dairy development over shallow.

Summary

It is imperative that the environmental fate of approximately 1 trillion micrograms of selenium that could be added to the Kings County environment on an annual basis as a result of this project be addressed by the County of Kings in the final environmental documents. At present the topic is not addressed at all. After more than 5 years of study, the FDA concluded in 1993 that a finding of no significant impact for such additions of selenium to the environment was not scientifically defensible. Consequently failing to mitigate for this issue could be in violation of the NEPA. Presumably this would apply also to the California Environmental Quality Act (CEQA). Due to the critical scientific uncertainties that led to FDA’s conclusion, risk management would require fairly extensive environmental monitoring of selenium at dairy development sites, manure application sites, and at all downstream surface water features. Mitigation should probably include the funding of substantive primary scientific research aimed at resolving the main uncertainties regarding the exact chemical form, the reactivity, and the environmental mobility of selenium in dairy cow liquid and solid manure.

The issue of lifetime load limits for other potentially toxic inorganic chemical constituents of dairy cow manure, such as copper and zinc, have not been adequately addressed in the PEIR. The
cumulative effects of repeated land applications of animal manure are known to present definite hazards with regard to accumulation of copper and zinc. The potential for environmental release of selenium or medical supplements commonly added to livestock feed, via land applications of manure, such as growth promoters and antibiotics, also has not been adequately addressed in the PEIR. The examination of groundwater issues should be re-evaluated keeping in mind that groundwater levels are very dynamic across much of Kings County. The extent of Kings County that is deemed suitable for dairy development appears to need re-examination in light of DWR (1997) groundwater maps. Upon consideration of the above issues, it is likely that the total size of dairy herds that can be supported in Kings County without significant adverse selenium impacts on the environment will be significantly lower than the estimates currently reported in the PEIR. The Service is also concerned that the proposed development, expansion, and/or operation of milk cow dairies, as proposed in the PEIR likely will result in take of the of the endangered San Joaquin kit fox and other federally listed species. These species likely would be affected through direct, indirect, cumulative, and interrelated/interdependent effects. Therefore, we recommend that the County of Kings require parties applying for permission for the development, expansion, and/or operation of milk cow dairies obtain the concurrence of the Service that adverse selenium effects to listed species will be avoided, or incidental take authorization pursuant to sections 7 or 10(a)(1)(B) of the Act has been obtained prior to issuance of any permits by your agency.

Thank you for your interest in conserving threatened and endangered species. Please contact Brian Peterson or Peter Cross at (916) 414-6655 if you have any questions about this letter.

Sincerely,

[Signature]

Jan C. Knight
Chief, Endangered Species Division

cc: California Department of Fish and Game, Fresno, California (Attn: Donna Daniels)
Literature Cited


