Draft

# Statewide Program EIR Covering General Waste Discharge Requirements for Biosolids Land Application

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# Acronyms and Abbreviations

| | |
|---|---|
| ARB | California Air Resources Board |
| ASA | American Society of Agronomy |
| | |
| Bay-Delta | San Francisco Bay/ Sacramento-San Joaquin River Delta |
| BMPs | best management practices |
| B.P. | before present |
| | |
| CAA | Clean Air Act |
| CAAQS | California Ambient Air Quality Standards |
| Caltrans | California Department of Transportation |
| CASA | California Association of Sanitation Agencies |
| CCA | Certified Crop Adviser |
| CCAA | California Clean Air Act |
| CCR | California Code of Regulations |
| CDFA | California Department of Food and Agriculture |
| CEC | cation exchange capacity |
| CEQA | California Environmental Quality Act |
| CFR | Code of Federal Regulations |
| CFU | colony forming units |
| CIWMB | California Integrated Waste Management Board |
| CNEL | community noise equivalent level |
| CNPS | California Native Plant Society |
| CO | carbon monoxide |
| Corps | U.S. Army Corps of Engineers |
| | |
| dBA | decibels above reference noise, A-weighted |
| DEHP | di-ethylhexyl phthalate |
| DFA | California Department of Food and Agriculture |
| DFG | California Department of Fish and Game |
| DHS | California Department of Health Services |
| DTSC | California Department of Toxic Substances Control |
| DWSWAP | Drinking Water Source Water Assessment and Protection |
| | |
| EIR | environmental impact report |
| EPA | U.S. Environmental Protection Agency |
| EQ | Exceptional Quality |
| ESA | Endangered Species Act |

| | |
|---|---|
| FCAA | federal Clean Air Act |
| FREP | Fertilizer Research and Education Program |
| GO | General Order |
| HWCL | California Hazardous Waste Control Law |
| LEA | local enforcement agency |
| MAF | million acre-feet |
| MCL | maximum contaminant level |
| mg/kg | milligrams per kilogram |
| mg/l | milligrams per liter |
| MLRA | Major Land Resource Area |
| MPN/gm | most probable number per gram |
| NAAQS | National Ambient Air Quality Standard |
| NDDB | Natural Diversity Data Base |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NO2 | nitrogen dioxide |
| NO3 | nitrate |
| NOA | notice of applicability |
| NOI | notice of intent |
| NOx | oxides of nitrogen |
| NOP | notice of preparation |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | U.S. Natural Resources Conservation Service |
| NWP | Nationwide Permits |
| O3 | ozone |
| ORNL | Oak Ridge National Laboratory |
| PAHs | polynuclear aromatic hydrocarbons |
| PCAs | possible contaminating activities |
| PCBs | polychlorinated biphenyls |
| P.L. | Public Law |
| PM2.5 | inhalable particulate matter less than 2.5 microns in diameter |
| PM10 | inhalable particulate matter less than 10 microns in diameter |
| POTW | publicly owned treatment works |
| ppm | parts per million |
| ROG | reactive organic gases |

| | |
|---|---|
| RWQCB | regional water quality control board |
| SIP | state implementation plan |
| SO2 | sulfur dioxide |
| SOCs | synthetic organic compounds |
| STLC | soluble threshold limit concentration |
| SWFP | solid waste facilities permit |
| SWRCB | California State Water Resources Control Board |
| TAG | technical advisory group |
| TLC | threshold limit concentration |
| TPD | tons per day |
| UC | University of California |
| USC | U.S. Code |
| USDA | U.S. Department of Agriculture |
| USFWS | U.S. Fish and Wildlife Service |
| VMT | vehicle miles traveled |
| WDR | waste discharge requirements |
| WHPA | Wellhead Protection Area |
| WWTP | wastewater treatment plant |
| FG/l | micrograms per liter |

# Executive Summary

# Executive Summary

## Introduction

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California. (The entire text of the proposed GO is included in Appendix A.) Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being used beneficially as a soil amendment for agriculture, silviculture, horticulture, and land reclamation. The GO would establish a notification and permit review process applicable to all persons and public entities intending to apply biosolids to land for the purposes stated above. The GO defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers would be required to adhere.

This EIR was originally certified in 1999. Litigation brought against the SWRCB after approval of the GO has resulted in this revision of the original program environmental impact report (PEIR). The court generally found the 1999 PEIR to be adequate, but concluded that two of the project alternatives were dismissed from detailed analysis without sufficient grounds. It decertified the EIR and set aside the approval of the GO pending revision and recertification of the EIR, with new analyses of the two alternatives. The court case is discussed in more detail under Post-Certification Litigation below.

Consistent with the order of the court, the following PEIR has been revised to include a detailed examination of two additional alternatives to the proposed GO: "Class A Only Alternative" and "Food Crop Limitation." These examinations are found in Chapter 14. In addition, where pertinent new information has become available since certification of the original PEIR, new discussions have been added. Other discussions have been updated to reflect changes in the regulatory environment that have occurred since certification of the original PEIR. These changes to the text of the 1999 Draft EIR are indicated by underlining new material and striking out outdated material. Text changes are also indicated by a dashed vertical line in the right-hand margin of the modified page.

## Purpose of the Statewide Program EIR

The purpose of this statewide program environmental impact report (EIR) is to comply with a Superior Court order by evaluating the environmental impacts of the SWRCB's adoption and implementation of a GO that would allow the issuance of general WDRs for land application of biosolids. The California Environmental Quality Act (CEQA) requires that state and local government agencies consider the environmental consequences of projects over which they have discretionary authority before taking action on those projects (Pub. Res. Code 21000 et seq.). The project analyzed in this document is the SWRCB's discretionary action on the GO; the underlying activity associated with this action is the land application of biosolids. CEQA also requires that each public agency mitigate or avoid, wherever feasible, the significant environmental effects of projects it approves or implements. Biosolids is defined as sewage sludge that has been treated and tested and shown to be capable of being beneficially and legally used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under 40 CFR part 503.

An EIR is an informational document used in state, regional, and local planning and decision-making processes to meet the requirements of CEQA. A program EIR is an EIR that is prepared for a series of actions that can be characterized as one large program, in this case the issuance of statewide regulations governing conduct of a continuing program (14 CCR 15168).

## Background on Biosolids Generation, Disposal, and Reuse

Treatment of municipal wastewater typically generates two waste streams: a liquid component and a solid or semisolid component. The liquid component, commonly referred to as effluent, usually is discharged to surface waters or percolation ponds or is used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB would apply to sewage sludges treated and tested to meet the definition of biosolids presented above. More than 50% of the biosolids generated in the United States are reused through some form of land application (Goldstein 1998).

This document will use the terms "beneficial use," "reuse," and "application" interchangeably to describe the application of biosolids to land. The term "disposal" is not

used to describe this activity in order to avoid confusion with the Part 503 regulations use of that term. Under Part 503, disposal involves the placement of biosolids on land at greater than the agronomic rate (i.e., the rate at which crops take up nitrogen). This includes placement in a landfill or a biosolids disposal facility. Disposal would also apply to the incineration of biosolids. Disposal is not intended to describe the use of biosolids as soil amendments or fertilizers.

Land application of biosolids is currently regulated by the U.S. Environmental Protection Agency (EPA) under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), which were adopted in 1993. Part 503 regulates the final use of biosolids by controlling the permissible levels of various constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. The Part 503 regulations apply to the generator of the biosolids, however, not the applier. The GO would apply to dischargers of biosolids rather than biosolids generators. The Part 503 regulations establish two pathogen reduction standards for land-applied biosolids: Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed.

No single state agency regulates land application of biosolids in California; biosolids recycling projects may involve oversight by the SWRCB, the nine regional water quality control boards (RWQCBs), the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA). The California Department of Health Services (DHS) acknowledges biosolids recycling efforts in its Manual of Good Practice for Landspreading Sewage Sludge (California Department of Health Services 1983). The IWMB has classified biosolids as a solid waste and thus exercises jurisdiction over biosolids use and disposal. The IWMB is responsible for regulating biosolids composting practices (14 California Code of Regulations [CCR], Division 7, Chapter 5), which requires recycling agencies to submit a permit application through the IWMB tiered permitting program. The IWMB designates a reasonable agency as the local enforcement agency (LEA), which sets standards and enforces solid waste regulations. Some counties have made land application of biosolids exempt from solid waste regulations, and others specify where and how disposal of biosolids can be conducted. Some counties have banned the land application of biosolids entirely.

In an effort to streamline the RWQCB application and permitting process for the use of biosolids, the Central Valley and Lahontan RWQCBs developed separate general waste discharge requirements (WDRs) (also called GOs) for biosolids land application in 1995 and adopted their programs after approving negative declarations under CEQA. Public agencies subsequently petitioned the SWRCB to set aside the RWQCB actions. During

the interim before the SWRCB decision, biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. The SWRCB remanded the Central Valley RWQCB GO in April 1996 as a result of legal challenges to the negative declaration but allowed for the continued land application of biosolids on sites for which permit coverage had been filed before April 1, 1996. In May 1996, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking that the SWRCB's interim permission for biosolids land application be rescinded under the GO unless an EIR is prepared. On June 12, 1997, the Superior Court decided that the SWRCB exceeded its authority in allowing the limited number of land application projects to proceed. On September 12, 1997, the Superior Court judge allowed for the continued application of biosolids on the subject sites and ordered the SWRCB to develop this statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The Lahontan GO was also subsequently remanded by the SWRCB, but no sites were permitted under this GO at that time.

In September of 2000 a lawsuit was filed by Kern County and other litigants against the ~~State Water Resources Control Board (~~SWRCB~~)~~ regarding the June 1999 version of this PEIR. This suit challenged various aspects of the adequacy of the PEIR. A hearing was held in July 2001 and a ruling was issued on August 2003. This ruling stated that the SWRCB generally complied with CEQA in developing and certifying the ~~EIREIREIR~~PEIR, however it ordered the PEIR de-certified pending recirculation of a revised PEIR that addressed two new alternatives. (Kern v. SWRCB 2002).

## Existing and Projected Biosolids Land Application in California

The methods available for biosolids management, and particularly land application of biosolids, are determined primarily by the quality of the generated product. Sewage sludges removed in municipal wastewater treatment plants can be treated to produce biosolids of sufficient quality for use as soil amendments or can be disposed of using the alternatives mentioned below. The three primary methods for reuse and disposal of biosolids are land application, surface disposal in a landfill, and incineration.

### Quantity of Biosolids Generated in California

The California Association of ~~SanitarySanitarySanitarySanitary~~Sanitation Agencies (CASA), a nonprofit organization of municipal utilities, conducted statewide surveys in 1988, 1991, and 1998 to estimate the quantity of biosolids generated and the uses of those biosolids (California Association of ~~SanitarySanitarySanitarySanitary~~Sanitation Agencies

1991, 1999). The 1988 and 1991 CASA survey results are derived from a database of 120 publicly owned treatment works (POTWs) in California.

CASA concluded that daily sludge disposal was 1,025 dry tons per day (TPD) in 1988; 1,610 dry TPD in 1991; and 1,842 dry TPD in 1998 (not all of the 120 POTWs submitted survey results). More than 70% of this material is generated at 10 POTWs that have wastewater flows in excess of 50 million gallons per day (mgd). The Los Angeles RWQCB region generates the greatest percentage (nearly 50%) of sludge among the nine RWQCB areas, followed in order by the Central Valley, San Francisco Bay, and Santa Ana regions.

## Disposal and Reuse Methods

Most of the biosolids being reused in California are generated in the Los Angeles and Orange County areas, as well as in the other large urban centers of the state (San Diego, the San Francisco Bay Area, Sacramento). Much of this material is transported a considerable distance by truck for land application. The counties supporting the largest amounts of biosolids reuse are ~~Kern, Kings,~~ Merced, San Diego, Riverside, and Solano.

Biosolids disposal and reuse methods in California include landfills, land application, composting, onsite storage and incineration. The 1988 CASA survey results estimates that approximately 60% of the biosolids generated in California were disposed of in landfills; the percentage decreased to approximately 45% by 1991. Land application and composting accounted for 18.7% and 21.7%, respectively, of biosolids reuse in 1991, and both uses had increased considerably from what was reported in 1988. The combined onsite storage and incineration of biosolids remained stable from 1988 to 1991 at approximately 14% of the total generated quantities. The 1998 information indicates a huge increase in land application, with nearly 68% of the material reported through the survey going to this reuse option. As a result, the percentage being disposed of in landfills was reduced to 9.1%. Incineration was the selected method of disposal for 5.6%, and 6.9% remained in onsite storage.

The GO regulates the use of biosolids for agriculture, horticulture, silviculture, and land reclamation. In general, the most common land application practice for biosolids is spreading and incorporation into agricultural lands. In California, horticultural use typically involves Class A Exceptional Quality biosolids that have been composted with various types of green waste. The use of biosolids for horticultural activities could include large-scale landscape plantings such as road medians, parks, and golf courses and as a planting or potting medium in large nursery operations.

Currently, no large-scale silvicultural uses (commercial tree farming operations) of biosolids are under way in California. Silvicultural uses are common in other parts of the country, however, including the Pacific Northwest. Additionally, land reclamation is not currently a major biosolids reuse option in California. The major use that would fall into this category is incorporation into final cover material at landfills. This use is not considered a disposal method because it is intended to increase the productivity of the cover soils. Other land reclamation uses could include incorporation into surface materials at mining reclamation sites or soil borrow areas where subsoil material with low growing potential is exposed at the surface.

### Future Biosolids Activity in California

Future biosolids production can be estimated based on population projections and per capita generation rates. Statistics were compiled from the California Department of Finance and CASA for use in this EIR. Based on census information, the population in urban areas in 1990(the date for which census data and CASA survey data most closely coincide) was 29.8 million (California Department of Finance 1998a), and this figure is expected to increase by approximately 42.3% to 42.4 million by 2015 (California Department of Finance 1998b). Based on the 1991 CASA estimate of biosolids generation (1,610 dry TPD) and assuming that the rate of per capita biosolids generation remains similar until 2015, the total estimated production of biosolids is expected to increase to 2,329 dry TPD. If the percentage of biosolids that are land applied remains constant in the next 15 years, the amount of material being land applied would be 1,579 dry TPD in 2015, with an annual total of 576,690 dry tons.

## General Order Program Objectives

The goal of the GO is to provide a clear and consistent regulatory process that is adequately protective of environmental resources, streamlines the permitting process for land application of biosolids, and includes policies and procedures that ensure continued refinement of biosolids disposal practices and protection of the environment. Therefore, the GO is intended to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on Notices of Intent (NOIs) filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids ~~disposal program for~~ land application ~~operations~~operationsoperationsoperations program at the regional level and contains requirements that are based on sound science and best professional judgment.

# Description of General Order

## Overview

The proposed GO was developed to provide a single regulatory framework for the land application of biosolids in California and to streamline the permitting process that each RWQCB uses for biosolids application projects. Provisions of the GO are based largely on the federal Part 503 regulations to ensure that the state regulation incorporates the extensive health risk assessments and scientific review that went along with developing the federal regulation. Baseline criteria that were established under the Part 503 regulations must be met under the GO and associated general WDRs. Projects that fail to meet the criteria established by the GO may still apply for an individual permit from the RWQCB. This section generally describes the principal permit conditions and procedures of the GO.

## Applicability

For the purposes of the GO, biosolids are defined as only those sewage sludges produced at municipal wastewater treatment plants that meet the requirements of the Part 503 regulations. Unstabilized sewage sludge, septage, and wastes that do not meet the Part 503 regulations or are determined to be hazardous under Title 22, Division 4.5, Chapter 11, Article 3 of the CCR would not be regulated under the GO.

Under the GO, the discharger is primarily defined as the landowner and generator, but may also include an individual, business, or organization involved in the generation,

transportation, use and application of biosolids. The discharger would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land that receive biosolids, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project must file a separate NOI, pay a separate filing fee, and list each generator associated with the proposed operation as co-dischargers. A permitted project for which the GO is applicable may involve a single application of biosolids or repeated applications. The identification of permitted activities under the GO does not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse. The discharger is responsible for making inquiries about permitted uses and obtaining applicable local permits and authorizations.

An important component of the GO is the requirement that each biosolids application project operator, before applying any biosolids, must prepare and submit an NOI for the area in which the biosolids are to be applied. The appropriate RWQCB would then review information contained in the NOI and, if it finds the information to be adequate, issues a Notice of Applicability under the general WDRs of the GO along with discharge monitoring requirements. A complete NOI includes a preapplication report that provides the RWQCB with specific information relating to each field or distinct application area.

An annual filing fee is required for each year that the project is operating and is based on the threat to water quality and complexity of the project as identified in 23 CCR 2200. Biosolids projects encompassing an area of 40-2,000 acres would be designated a Category II threat to water quality and given a Category “b” complexity rating. Biosolids projects of less than 40 acres would be classified a Category III threat to water quality and given a Category “b” complexity rating.

## Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program:

- Biosolids must be treated to reduce potential disease-causing pathogens.
- Class A biosolids have been treated sufficiently that pathogens are essentially eliminated; Class A biosolids must be monitored for bacteria growth at the time of use.

- Class B biosolids have been treated sufficiently that pathogens are substantially reduced, but not completely eliminated. Land application of biosolids that meets Class B criteria is restricted by the following conditions:
  - food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;
  - food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;
  - food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;
  - food and fiber crops cannot be harvested for 30 days after biosolids application;
  - animals cannot be grazed on the site within 30 days of biosolids application;
  - turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);
  - public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application;
  - grazing of milking animals used for producing unpasteurized milk for human consumption is prevented for at least 12 months if the field is used as pasture; and
  - public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes and management practices that the biosolids must undergo to reduce vector attraction. Biosolids must be treated to meet at least Class B criteria for pathogen reduction and vector reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of 10 metals, nine of which are regulated under the Part 503 regulations (see the discussion below in “Discharge Prohibitions of the

GO" and "Discharge Specifications of the GO"). Restrictions on pollutant addition levels are described in "Discharge Specifications in the GO".

## Discharge Prohibitions of the GO

The GO contains prohibitions that apply to all land application projects that request authorization. In general, biosolids must not be applied under the following conditions:

- the biosolids to be discharged cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;
- the biosolids cannot be discharged except as allowed at authorized storage, processing, and land application sites;
- no application is permitted until the RWQCB has issued a Notice of Applicability, a set of individual WDRs, or a waiver of WDRs;
- no application is permitted if the discharge would cause or threaten to cause pollution or create a nuisance as defined by Section 13050 of the California Water Code;
- no application is permitted that would cause a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5);
- no application is permitted to areas not specified in the applicant's NOI;
- no application is permitted to surface waters or drainage courses;
- no application is permitted when the application rate would exceed the nitrogen requirements of the vegetation or the rates that would degrade groundwater unless specifically authorized (application in excess of nitrogen requirements may be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade the quality of underlying groundwater);
- no surface water runoff resulting from irrigation of the site is permitted within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;

- no application is permitted to frozen or water-saturated ground or during periods of rain heavy enough to cause runoff from the site;
- the application of biosolids containing a moisture content of less than 50 percent is prohibited;
- no application is permitted in areas subject to erosion or washout offsite; and
- discharge of biosolids with pollutant concentrations greater than specified levels is prohibited.

## Discharge Specifications of the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be land applied. Most of these specifications are similar to the requirements of the Part 503 regulations and include the following:

- Biosolids must be treated to meet Part 503 standards for vector reduction and be treated to either the Class A or Class B level of pathogen reduction standards.
- Cumulative lifetime metals loading limits for a given application site shall not exceed specified levels (including background soil levels and levels in applied biosolids).
- Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed for reclamation sites or biosolids research projects.
- Following incorporation of biosolids into the soil, tilling practices must minimize erosion of the site resulting from wind, stormwater, and irrigation water.
- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.
- For Class B biosolids, the harvesting period for crops is restricted as described in the Part 503 regulations. In addition, the location of application is specified with respect to property lines, municipal and agricultural supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

## Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirement for biosolids to be transported in covered, leakproof vehicles; drivers must carry a copy of an approved spill response plan and be trained with regard to the proper response to accidents or spill events. The GO defines short-term storage as placement of biosolids on the ground or in nonmobile containers for longer than 48 hours, but less than 7 consecutive days at an intermediate site other than the place of generation and/or processing. If biosolids are to be stored at the application site, the operator must prepare and implement an RWQCB-approved storage program. Biosolids must not be stored for longer than 7 consecutive days; storage areas must be covered between October 1 and April 30 during periods of runoff-producing precipitation; public access to storage areas must be restricted; and control measures should be implemented to prevent leachate into the soil, surface runoff, and washout from floods.

## Provisions

The GO contains 20 general conditions and procedures that must be followed by the discharger. The general provisions are summarized under the following categories of responsibilities:

- **Obtaining, maintaining, and terminating coverage under the GO:** An NOI must be submitted for each biosolids source and discharge site. Specific agencies, adjacent residents, and adjacent landowners identified in the GO and any local agency with jurisdiction over the application site must be notified. The RWQCB must be notified in advance of any transfer of the project to another party. The RWQCB must be notified of project completion through submittal of a Notice of Termination and a Final Discharge and Monitoring Program report. Provisions of the general WDRs issued by the RWQCB are severable.

- **Chain of responsibility:** Individual property owners and companies responsible for biosolids discharges and site operations are primarily accountable for compliance and enforcement actions under the GO. The discharger is responsible for informing all biosolids haulers using the land application site of the conditions contained in the GO. Individual property owners are responsiblefor applicable crop selection, property access, and harvesting restrictions under the GO.

- **Monitoring, reporting, and record keeping:** The preapplication form that is attached to the GO describes the general reporting requirements and specific groundwater monitoring requirements (if deemed necessary). Groundwater monitoring would generally be required if the depth to groundwater at the disposal site is less than 25 feet and biosolids would be applied to the site more than twice in a 5-year period. If required, one upgradient and two downgradient wells must be monitored annually at each application site to evaluate water level, pH, total dissolved solids, sodium, chloride, nitrate, and total nitrogen levels. The discharger is responsible for implementing the requirements of the GO and for site operations and conducting the required monitoring programs. Sampling must be conducted using approved methods, accurate and properly calibrated equipment, and certified laboratories. Information that must be recorded includes the quantity of biosolids applied at each site along with its nitrogen content, crops grown, and total pollutant loading. The discharger must notify the RWQCB of any noncompliance with the GO within 24 hours. The discharger must keep monitoring records for at least 3 years. Annual monitoring reports submitted to the RWQCB must be signed and certified by the discharger or a duly authorized representative.

## General Order Exclusion Areas

The proposed GO specifies several areas of the state within which biosolids application projects under the GO cannot be permitted. Generally, the exclusion areas are unique or valuable public resources, jurisdictional waters or preserves, or state-designated management areas. The general areas excluded from this GO are the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta;
- Suisun Marsh;
- the area under the jurisdiction of the San Francisco Bay Conservation and Development Commission; and

- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,500 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and areas of the Mono-Owens Planning Area.

These areas are not included in the analysis of this EIR.

## Alternatives to the Proposed Project

In accordance with State CEQA Guidelines Section 15126.6, an EIR must describe a range of reasonable alternatives to the project, or to the location of the project, that would feasibly attain most of the basic project objectives of the proposed project but would avoid or substantially lessen any of the significant effects of the project, and must evaluate the comparative merits of these alternatives. An EIR does not need to consider every conceivable alternative to a project; rather, it must consider a reasonable range of potentially feasible alternatives that will foster informed decision making and public participation. State CEQA Guidelines Section 15126.6(d) allows for alternatives to be analyzed in lesser detail than the proposed project. In response to litigation over the prior version of this EIR, the Class A Only and Food Crop Limitation alternatives are also discussed.

The alternatives to the proposed project were developed to comply with CEQA and are based on input received during the public scoping period. The No-Project Alternative was developed to comply with CEQA. The Modified General Order Alternative is included because it would achieve the project's objectives and would result in reduced impacts compared with the proposed project. Although the Land Application Ban Alternative would not meet the project's basic objectives, it was included in the alternatives analysis to respond to issues identified during the public scoping period.

## Impacts of the Proposed General Order

Table ES-1 (at the end of this chapter) presents a summary of project impacts and mitigation measures under the proposed project. Details of the mitigation measures can be found in each relevant technical chapter. Additionally, a mitigation monitoring program is included in Chapter 15, "Mitigation Monitoring Program".

## Table ES-1.
## Summary of Impacts and Mitigation Measures for the California State Water Resources Control Board General Waste Discharge Requirement for Biosolids Land Application

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| **Soils, Hydrology, and Water Quality** | | | |
| Changes to existing drainage patterns or increase in surface runoff | Less than significant | None required | Less than significant |
| Changes in groundwater supply and hydrology | Less than significant | None required | Less than significant |
| Potential degradation of surface water from nutrients in biosolids | Less than significant | None required | Less than significant |
| Potential degradation of groundwater from nutrients | Less than significant | None required | Less than significant |
| Potential degradation of surface water and groundwater from trace elements in biosolids | Less than significant | None required | Less than significant |
| Potential degradation of surface water and groundwater from synthetic organic compounds in biosolids | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| | | **Land Productivity** | |
| Changes in physical soil properties and resulting effects on productivity | Less than significant | None required | Less than significant |
| Changes in soil fertility and salinity and resulting effects on productivity | Potentially significant | 4-1: Provide soil- and site-screening information with the pre-application report | Less than significant |
| Changes in trace elements and heavy metal plant toxicity in soils and resulting effects on productivity | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report | Less than significant |
| Changes in amount of synthetic organic compounds in soils and resulting effects on agricultural productivity | Less than significant | None required | Less than significant |
| Changes in grazing-land productivity | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report<br>4-2: Extend grazing restriction period to allow for SOC biodegradation | Less than significant |
| Increases in soil erosion rates and resulting effects on production | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report | Less than significant |
| Changes in farmland classification | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| Effect on agricultural lands caused by public concerns about crop contamination from biosolids applications | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report<br><br>4-2: Extend grazing restriction period to allow for SOC biodegradation<br><br>4-3: Track and identify biosolids application sites | Less than significant |
| Changes in soil nutrient properties and resulting effects on productivity for silvicultural activities | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report | Less than significant |
| Potential soil degradation at recreation-area ~~apploication~~applo~~o~~ication sites | Less than significant | None required | Less than significant |
| Potential soil degradation | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report<br><br>4-2: Extend grazing restriction period to allow for SOC biodegradation | Less than significant |
| **Public Health** | | | |
| Potential for increased incidence of disease resulting from direct contact with pathogenic organisms at biosolids land application sites | Less than significant | 5-1: Review manual of good practices (recommended) | Less than significant |
| Potential for increased incidence of disease resulting from direct human contact with pathogenic organisms in irrigation runoff from biosolids land application sites | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| Potential for increased incidence of disease resulting from ingestion of pathogenic organisms in crops grown on land application sites or animals fed with crops grown on land application sites | Potentially significant | 5-2: Extended grazing deferment period to allow for pathogen reduction | Less than significant |
| Potential for increased incidence of chronic human disease resulting from ingestion of biosolids-derived metals in crops grown on land application sites or animals fed with crops grown on land application sites | Less than significant | None required | Less than significant |
| Potential for increased risk of chronic disease resulting from ingestion of biosolids-derived organic compounds in food, soils, animals, dairy products, or wildlife | Less than significant | None required | Less than significant |
| Potential for increased incidence of disease resulting from ingestion of groundwater contaminated by biosolids-derived pollutants or pathogens | Less than significant | None required | Less than significant |
| Potential for increased incidence of acute or chronic disease resulting from human exposure to aerosols and wind-blown particulates from biosolids stockpiling, composting, or land application | Less than significant | 5-3: Good management practices should include the wearing of respirators or masks by workers. | Less than significant |
| Potential for increased risk of disease resulting from contact with biosolids spilled during transport from point of generation to application site | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| Potential for exposure of residents and agrigultural workers to unsafe levels of radionuclides after long-term application of biosolids. | Significant | 5-4: Follow ISCORS management recommendations | Less than significant |
| **Land Use and Aesthetics** | | | |
| Application of biosolids in a manner and/or in locations in conflict with local land use plans and ordinances, including future planned land uses | Less than significant | None required | Less than significant |
| Application of Class B biosolids at locations that may conflict with existing land uses in urban areas; recreation areas; or other sensitive areas, including schools, hospitals, and recreation/public assembly areas | Potentially significant | 6-1: Require injection of biosolids in areas defined as having a high potential for public exposure for Class B biosolids | Less than significant |
| Reduced visual quality resulting from truck transport of biosolids through residential and/or recreational areas | Significant | 10-2: Control fugitive dust from unpaved roads<br><br>11-1: Avoid the use of haul route near residential lands | Less than significant |
| Reduced visual quality resulting from land application activities adjacent to schools, hospitals, or recreation/public assembly areas | Potentially significant | 10-2: Control fugitive dust from unpaved roads | Less than significant |
| Reduced visual quality resulting from spillage of biosolids on public roads | Significant | 6-2: Require the maintenance of biosolids transport trucks after biosolids are loaded in the trucks | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| **Biological Resources** | | | |
| Reduction in the number of a special-status plant or wildlife species | Significant | 7-1: ~~Conduct a site assessment on natural terrestrial habitat and fallow lands for special-status plant and wildlife species~~Modify pre-application report and provide biological information | Less than significant |
| Substantial disturbance of biologically unique or sensitive natural communities | Significant | 7-2: ~~Conduct~~Modify pre-application report ~~site assessment~~ and provide information on ~~natural terrestrial habitats for~~ biologically unique or sensitive natural communities | Less than significant |
| Potential for physiological effects of biosolids application on wildlife | Less than significant | None required | Less than significant |
| **Fish** | | | |
| Potential for acute toxicity to fish from leaching of biosolids constituents from application sites to surface waters | Potentially significant | 8-1: Increase setback from enclosed water bodies if pupfish are present | Less than significant |
| Potential for reduced fisheries productivity resulting from runoff and erosion | Potentially significant | 4-1: ~~Develop a~~Provide soil- and site-screening information with the pre-application report | Less than significant |
| **Traffic** | | | |
| Potential increase in traffic resulting from the transport of biosolids | Less than significant | None required | Less than significant |
| Deterioration of roadway surfaces | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| Potential for roadway safety hazards resulting from accidental spills | Less than significant | None required | Less than significant |
| **Air Quality** | | | |
| Significant increase in ROG, NOx ,and PM10 from biosolid transport vehicles and biosolids spreaders | Less than significant | None required | Less than significant |
| Exposure of sensitive receptors to odors | Less than significant | None required | Less than significant |
| Biosolids drift associated with wind-blown biosolids | Less than significant | None required | Less than significant |
| **Noise** | | | |
| Exposure of noise-sensitive land uses to noise resulting from the transport of biosolids | Significant | 11-1: Avoid the use of haul routes near residential land uses | Less than significant |
| Exposure of noise-sensitive land uses to noise from the land application of biosolids | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| | | **Cultural Resources** | |
| Damage to or destruction of cultural resources on lands not previously disturbed by agricultural activities | Significant | 12-1: Conduct a cultural resources investigation | Less than significant |
| Damage to or destruction of unknown cultural resources on lands currently in agricultural production | Significant | 12-2: Comply with state laws regarding disposition of Native American burials, if such remains are found | Less than significant |
| | | **Cumulative Impacts** | |
| Cumulative nitrate contamination of groundwater | Potentially significant | 13-1: Minimize contribution to groundwater nitrate contamination from land application of biosolids conducted under the GO<br>13-2: Reduce Sources of Nitrate Contamination | Less than significant |
| ~~Cumulative Reduction in Fisheries Productivity 13-1: Minimize Contribution to Groundwater Nitrate Contamination from Land Application of Biosolids Conducted under the GOLess than significant13-2: Reduce Sources of Nitrate Contamination~~Cumulative loss of ~~Special-Status~~ special-status plant and wildlife species or the loss or disturbance of biologically unique or sensitive natural communities | Less than significant | None required | Less than significant |

| Impact | Level of Significance before Mitigation | Mitigation Measure | Level of Significance after Mitigation |
|---|---|---|---|
| Cumulative increase in $NO_x$ and PM10 emissions | Less than significant | None required | Less than significant |
| Cumulative deterioration of roadways | Less than significant | None required | Less than significant |

# Environmentally Superior Alternative

CEQA requires that~~ the lead agency~~, where the no-project alternative is the environmentally superior alternative, that the EIR identify the environmentally superior alternative from among ~~those~~ th~~os~~e ~~evaluated in the EIR that are within the reasonable range of~~ ~~of~~other alternatives.~~.~~ The Modified General Order Alternative is the environmentally superior alternative because it reduces the potential for significant environmental effects when compared to the proposed GO and it is within the reasonable range of alternatives. The Modified GO would include various additional discharge requirements that take into account some of the unusual conditions that exist in regions of California that ~~are likely to~~might receive land-applied biosolids. It also contains the requirements for some additional data and technical analysis to be available to the RWQCB staff when evaluating individual land application permits.

Under the Modified General Order Alternative, potential impacts related to water quality, land productivity (including trace elements and heavy metals in soils), soil erosion, crop contamination, public health risk, land use compatibility, reduced visual quality, potential loss of special-status plant and wildlife species or biologically unique or sensitive natural communities, air quality emissions exceeding significance thresholds for air districts, exposure of sensitive receptors to noise, and disturbance of significant cultural resources would not occur because measures have been incorporated into the design of this alternative to avoid these impacts.

The Class A Only and Food Crop Limitation alternatives would avoid the impacts identified for the proposed GO (before mitigation) and have a similar level of impacts to the Modified GO alternative. However, neither of them is an environmentally superior alternative when compared to the Modified GO. Both the Class A Only and Food Crop Limitation alternatives would have greater levels of impacts with regard to truck traffic, air quality, and energy use. The additional effects would occur as treatment plant operators that are currently land-applying Class B biosolids convert to more energy-intensive Class A treatment or decide to haul biosolids to distant land application or disposal sites.

# Other CEQA-Required Impact Conclusions

## Cumulative Impacts

State CEQA Guidelines Section 15130 requires that an EIR discuss cumulative impacts of a proposed project when the incremental effects of an individual project would be considerable viewed in connection with the effects of past projects, the effects of current projects, and the effects of probable future projects. Additionally, the State CEQA Guidelines state that when a lead agency is examining a project with an incremental effect that is not cumulatively considerable, a lead agency need not consider the effect significant but shall briefly describe its basis for reaching that conclusion. Land application of biosolids could contribute to less-than-significant cumulative impacts for ~~the following resources: groundwater, fish,~~ biological resources, air quality, and transportation and a significant cumulative impact for groundwater. Cumulative impacts on these resources are discussed in Chapter 13.

## Growth-Inducing Impacts

State CEQA Guidelines Section 15126.6(d) requires an EIR to include a discussion of the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment.

The land application of biosolids would not be growth inducing because it would not foster economic or population growth or remove any obstacles to growth in California. Land application of biosolids is an existing activity in California and would not induce growth as a result of adopting the proposed GO.

## Significant and Unavoidable Impacts

CEQA requires that an EIR identify any significant and unavoidable impacts of the proposed project. Implementation of the GO would not result in any significant and unavoidable impacts.

## Irreversible Commitment of Resources and Significant Irreversible Environmental Changes

State CEQA Guidelines Section 15126~~.6(c)~~ requires that an EIR include a discussion of any irreversible commitment of resources that would occur as a result of project implementation. Irreversible commitment of resources would occur as a result of implementing the proposed project. These resources include fossil fuels, labor, and energy required for transporting and spreading biosolids.

CEQA also requires that an EIR identify any significant irreversible environmental changes that could result from the project. Although there is the potential for accidental spills of biosolids to occur during transportation of the biosolids to the application site, the GO requires that biosolids be transported in covered, leakproof vehicles; therefore, accidental spills of biosolids resulting from transporting biosolids to a site are unlikely because of the measures incorporated into the GO. If spills did occur, it would be unlikely that an irreversible environmental change would occur. Additionally, land application of biosolids would generally occur on lands that are currently in agricultural production. It is unlikely that significant amounts of land would be converted from nonagricultural to agricultural land use (or to silvicultural, horticultural, or land reclamation use) as a result of this project.

## Known Areas of Controversy

State CEQA Guidelines Section 15123(b) requires that an EIR identify areas of controversy known to the lead agency, including issues raised by other agencies and the public. The following are known areas of controversy for regulating the land application of biosolids expressed during the scoping and preparation of this EIR.

**Validity of Scientific Data Used during the Formulation of Part 503 Regulations.** Numerous comments were received during the scoping process for the draft EIR regarding the validity of the scientific data used by EPA when formulating the Part 503 regulations. These concerns, including those expressed in the Cornell Waste Management Institute's 1999 working paper (Cornell Waste Management Institute 1999) have been reviewed and taken into consideration in preparing the impact analyses in this EIR. The proposed GO includes land application controls that are more stringent than those included in the Part 503 regulations to account for unusual conditions that may exist in California and differences of opinion that may exist about the adequacy of the Part 503 regulations.

**Reduced Property Values where Land Application Occurs.** Issues were raised during the scoping process for the draft EIR regarding the potential for reduced property values on and adjacent to sites where land application occurs. Potential property value effects have not been addressed in this EIR, as they would be an economic rather than an environmental effect. Property value effects are considered speculative at this time.

**Loss of Crop Value as a Result of Public Perception.** Another known area of controversy raised during the scoping process for the draft EIR was the potential for a decrease in crop value resulting from the public perception of biosolids being applied to the soil where these crops were grown. Additionally, concern was raised that crop value would be reduced for land adjacent to parcels where biosolids land application has occurred because the public or food processors could believe that the crops were grown on soil containing biosolids or were contaminated by the adjacent site where biosolids have been used. This issue has been addressed in Chapter 4, "Land Productivity" with regard to the productive value of the land. The potential economic effects are not discussed because they are considered speculative and would not result in a physical change in the environment.

**Increase in Operation Costs.** Concerns were raised about the GO's effect on operating costs at POTWs. If POTW costs are increased to meet additional treatment and reuse restrictions, the cost to the general public for wastewater treatment might also increase. Although the cost of biosolids treatment and management might increase to meet all of the terms of the GO, the economic effects have not been predicted in this EIR because they are not considered environmental impacts.

**Availability of RWQCB Resources to Adequately Monitor and Enforce the GO.** Several comments received during the scoping process for the draft EIR related to the ~~availabilityavailabilityavailability~~ability of the RWQCBs to adequately monitor and enforce the GO. The RWQCBs are the state enforcement agency charged with regulating the land application of biosolids. Members of the public and agency staff indicated that both funds and staffing resources would be needed for the RWQCBs to adequately administer this additional regulatory program. Much of the public concern regarding the viability of the GO has related to its reliance on strong monitoring and enforcement actions.

**Significance of Certain High-Profile, Widely Publicized Human Diseases.** Several comments also were received regarding certain high-profile, widely publicized human diseases, such as AIDS, hepatitis, "mad cow" disease, hormone inhibitors, and Legionnaire's disease. Chapter 5, "Public Health", discusses the potential for these diseases to occur as a result of implementing the proposed GO. Because there is not a large body of research regarding the ability of these diseases ~~and their ability~~ to be transmitted specifically in biosolids, the ~~potential for a~~ public health ~~risk~~risks are considered speculative

and the potential for these risks will continue to be studied~~ and will remain subject to varying opinions~~.

**General Public Acceptance of Reusing Human Waste.** Another known area of controversy is the public acceptability of reusing human waste. Although human waste has been used as a resource by various cultures worldwide for thousands of years, the potential public health risk and the tendency to remove this material from today's modern society will continue to make land application a controversial action. The agencies and associations interested in maintaining the resource value of biosolids are attempting to change public perception through education and additional research~~ on public~~.

**Health Risks Posed by Dioxins.** Human health risks posed by exposure to dioxins in biosolids is also an area of controversy. To address this area of uncertainty, the EPA has recently concluded a five year study that looked at the health risks of dioxins in biosolids. ~~Their~~Its study, which was undertaken as part of the consideration of additional Part 503 regulations, determined that dioxins from this source do not pose a significant risk to human health or the environment. The EPA's analysis showed that, even for a theoretical farm family that applies biosolids as a fertilizer to crops and animal feed and then consumes those crops and animals, 0.003 new cases of cancer could be expected each year or 0.22 new cases over a span of 70 years. The EPA found that the risk to the general population is even smaller due to the lower exposures from this source. In addition, the 2001 Dioxins Update to the National Sewage Sludge Survey found that the presence of dioxins in biosolids ~~is so insubstantial that they do not pose a significant risk to human health. As a result of this study, the EPA has decided not to amend Part 503 to regulate dioxins in biosolids. (EPA 2003).~~
has decreased since the EPA's last survey in 1988. The EPA expects this downward trend to continue, as a result of stricter regulatory controls on additional sources of dioxins in the environment.

**Petition to EPA for Moratorium on Land Application.** On October 7, 2003, the Center for Food Safety (Center), on behalf of some 72 other organizations, petitioned the EPA seeking an emergency moratorium on the land application of sewage sludge (i.e., biosolids). The petition requested that EPA halt the issuance of new NPDES permits and rewrite current NPDES permits that would allow the land application of biosolids. In addition, the petition requested that the EPA immediately initiate a rulemaking to eliminate land application as an acceptable use of biosolids. (Center for Food Safety 2003). The Center based its petition on the following claims: that biosolids contain heavy metals and other hazardous materials that have been applied to farmland; that there is "considerable anecdotal evidence" that the land application of biosolids has resulted in harm to people, livestock, and the environment; and that because of "the inherently unpredictable and inherently hazardous nature of sewage sludge" the EPA is "unable to implement any program or regulatory scheme to protect public health or the environment" from land

application of biosolids. The Center referenced three specific instances of human deaths and a case of dairy cow deaths where claims were made that exposure to biosolids was a causative factor.

The EPA responded by letter on December 22, 2003, denying the Center's petition. The EPA's response addressed each of the allegations made by the Center.

Regarding claims of adverse health effects, the EPA found that "none of these claimed adverse health effects have been proven or substantiated as having been caused by exposure to land-applied sewage sludge." After examining the information provided in the petition and other sources, the EPA concluded that there is "no evidence that exposure to land-applied sewage sludge was the cause of any of the allegations of adverse health effects or the specific human and animal deaths cited by the petitioners." (U.S. Environmental Protection Agency. 2003x) The EPA will be cooperating with the Federal Centers for Disease Control and Prevention (CDC) to undertake a comprehensive review of reported human health effects as part of its final action plan in response to the NRC "Biosolids Applied to Land" report. (68 Federal Register 75531)

Regarding toxic levels of chemicals in biosolids, the EPA cited studies in which testing of biosolids samples from around the country have demonstrated that sewage sludge does not qualify as a hazardous waste under RCRA, that sewage sludge meets federal regulations for metals content, and that pretreatment programs for industry have led to a decrease in the concentrations of potentially hazardous or toxic elements in sewage sludge over the past 20 years. The EPA also noted that the Agency is pursuing an active research program for certain contaminants.

Regarding program oversight, the EPA listed its current and future efforts in enforcement and compliance. It also described the roles of state and local health agencies and the CDC in responding to reports of adverse health effects.

## Required Permits and Approvals

State CEQA Guidelines Section 15124 states that an EIR must include a list of the agencies that expect to use the EIR in their decision making and a list of the approvals required to implement the project. In order for the proposed GO to be implemented, the SWRCB would adopt the GO and certify the EIR. With the exception of the RWQCBs, no other agencies would use the EIR for decision making purposes. No other permits or approvals would be required.

# Chapter 1. Introduction

# Chapter 1. Introduction

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California (the entire text of the proposed GO is included in Appendix A). Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation. The GO would establish a notification and permit review process for all persons and public entities intending to apply biosolids to land for purposes stated above. The GO defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers would be required to adhere.

This chapter briefly describes the background and existing regulations for land application of biosolids in California. In addition, the chapter describes the purpose of the program environmental impact report (EIR) that is being prepared in accordance with the California Environmental Quality Act (CEQA) and the State CEQA Guidelines, the scope of issues to be addressed, and the organization of the EIR.

As indicated later in this chapter, the EIR has been revised from an earlier program EIR that was the subject of a lawsuit in 2000. Modified text is highlighted througout the document using strikeout for outdated material, and underlining for new material. Changes are also indicated by a vertical dashed line in the right-hand margin.

## Background on Biosolids Management in California

Treatment of municipal wastewater typically generates two waste streams: a liquid component and a solid or semisolid component. The liquid component, commonly referred to as effluent, usually is discharged to surface waters or percolation ponds or is used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB will apply to sewage sludges treated and tested to meet the definition of biosolids as presented above.

More than 50% of the biosolids generated in the United States are reused through some form of land application (Goldstein 1998). Land application differs from disposal in that biosolids are applied to condition soil and satisfy or supplement the nutrient requirements of crops or vegetation. Disposal options for biosolids typically include landfilling or incineration. Land application may involve the use of biosolids on traditional agricultural crops, on commercial tree farms, for reclamation of disturbed lands, or in the application of composted or thermally processed materials to public-use areas such as parks and residential landscaping. Certain precautions must be observed to ensure that land application does not endanger public health or adversely affect the environment. The U.S. Environmental Protection Agency (EPA) considers land application a beneficial use because it recycles the nutrients and organic matter contained in biosolids back to the soil (U.S. Environmental Protection Agency 1994).

## Existing Regulations for Land Application of Biosolids

Land application of biosolids is currently regulated by EPA under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), adopted in 1993. In designing the Part 503 regulations, EPA used a risk-based approach to develop appropriate treatment, storage, and application procedures for biosolids that are intended to protect human health and the environment from potentially dangerous or toxic constituents that may be present in biosolids. The Part 503 regulations regulate the final use of biosolids according to the constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. However, the Part 503 regulations apply to the generator of the biosolids, not the applier. Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed. The regulation was developed through extensive scientific peer review, and public notification and comment were sought before the regulation was adopted. Many state and local agencies now rely on the Part 503 rules for regulatory guidance.

No single state agency regulates ~~land application of~~ biosolids management in California; biosolids recycling projects may involve oversight by ~~the SWRCB,~~ the nine regional water quality control boards (RWQCBs) (Figure 1-1), the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA). The California Department of Health Services (DHS) acknowledges biosolids recycling efforts in its Manual of Good Practice for Landspreading Sewage Sludge (California Department of Health Services 1983). The IWMB has classified biosolids as a solid waste and thus exercises jurisdiction over the use and disposal of biosolids. The IWMB is responsible for regulating biosolids composting practices (14 California Code of Regulations [CCR], Division 7, Chapter 5), which requires recycling agencies to submit a permit application under the IWMB tiered

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**Figure 1-1**
**Regional Water Quality Control Board Boundaries**

permitting program. The IWMB designates a responsible agency as the local enforcement agency (LEA), which sets standards and enforces solid waste regulations. On the local level, some counties have made land application of biosolids exempt from solid waste regulations, and others specify where and how disposal of biosolids can be conducted. Some counties have banned the use of biosolids.

In an effort to streamline the RWQCB application and permitting process for the use of biosolids, the Central Valley and Lahontan RWQCBs developed separate general waste discharge requirements (WDRs) (also called GOs) for biosolids land application in 1995 and adopted their programs after adopting negative declarations under CEQA. Public agencies subsequently petitioned the SWRCB to set aside both RWQCB actions. However, biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. The SWRCB remanded the Central Valley RWQCB GO in April 1996 as a result of CEQA challenges of the negative declaration but allowed for the continued land application of biosolids on sites for which permit coverage had been filed before April 1. 1996. In May 1996, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking that the SWRCB's interim permission for biosolids land application be rescinded under the GO unless an EIR is prepared. On June 12, 1997, the Superior Court decided that the SWRCB exceeded its authority in allowing the limited number of land application projects to proceed. On September 12, 1997, the Superior Court judge allowed for the continued application of biosolids on the subject sites and ordered the SWRCB to develop this statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The Lahontan GO was also subsequently remanded by the SWRCB, but no sites were permitted under this GO at that time.

In September of 2000 a lawsuit was filed by Kern County and other litigants against the SWRCB regarding the June 1999 version of this PEIR. This suit challenged various aspects of the adequacy of the PEIR. A hearing was held in July 2001 and a ruling was issued on August 2003. This ruling stated that the SWRCB generally complied with CEQA in developing and certifying the EIR, however it ordered the PEIR de-certified pending recirculation of a revised PEIR that addressed two new alternatives. This is discussed in more detail under Post-Certification Litigation below. (Kern v. SWRCB 2002).

## Purpose of the Statewide Program EIR

The purpose of this statewide program EIR is to comply with the Superior Court order by evaluating the environmental impacts of the SWRCB's adoption and RWQCB implementation of a GO that would allow the issuance of general WDRs for the land application of biosolids. CEQA requires that state and local government agencies consider the environmental consequences of projects over which they have discretionary

authority before taking action on those projects (Pub. Res. Code 21000 et seq.). The project analyzed in this document is the SWRCB's discretionary action on the GO; the underlying activity associated with this action is the land application of biosolids. CEQA also requires that each public agency mitigate or avoid, wherever feasible, the significant environmental effects of projects it approves or implements.

An EIR is an informational document used in state, regional, and local planning and decision-making processes to meet the requirements of CEQA. A program EIR is an EIR that is prepared for a series of actions that can be characterized as one large program, in this case the issuance of statewide regulations governing conduct of a continuing program (14 CCR 15168).

# The Scoping Process

Section 15083 of the State CEQA Guidelines authorizes and encourages an early consultation or scoping process to help identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in an EIR and to help resolve concerns of affected agencies and individuals. The intent of the scoping process is to identify the significant issues for study in the EIR and to determine the scope of the analysis of each issue. Scoping is designed to explore issues for environmental assessment to ensure that important considerations are not overlooked and to uncover concerns that might otherwise go unrecognized. Scoping has allowed the SWRCB to make the program EIR as complete and informative as possible for decision makers and those affected by the proposed action and its alternatives. This section describes the scoping activities sponsored by the SWRCB.

## Notice of Preparation

A notice of preparation (NOP), which is required by CEQA, is the first effort to involve the public and interested agencies in the scoping process. The NOP describes the proposed project or program, indicates the types of environmental effects that could result from implementation of the program, and announces the start of an EIR review process under CEQA. The NOP encourages public participation in the environmental evaluation.

On October 21, 1998, the SWRCB sent an NOP of the statewide program EIR to more than 200 agencies and persons with potential interest in the program. Copies of the NOP were available for review at the SWRCB and each RWQCB office. Additionally, the NOP was posted at the SWRCB home page (http://www.swrcb.ca.go) and an announcement of its availability was forwarded to more than 300 individuals. The SWRCB developed a mailing list of agencies, organizations, and individuals interested in

receiving the NOP and scoping meeting announcements. The list also was used for distribution of this EIR. The NOP and the distribution list for the NOP are included in Appendix B.

## Other Scoping Activities

### Scoping Meetings

The SWRCB staff held scoping meetings on the following dates and at the following locations:

- November 9, 1998 - Bakersfield
- November 10, 1998 - Palmdale
- November 16, 1998 - Davis

The scoping meetings were held to solicit input from agencies and interested parties on issues to be addressed in the program EIR. The scoping meetings included a description of the meeting's purpose, a description of the proposed GO regulatory program, a presentation of the conceptual environmental effects and program alternatives, an overview of the environmental review process and preparation of the EIR, and a public comment period. Those in attendance made comments on issues related to the GO program and on the alternatives proposed for the EIR. The scoping meetings were advertised in five publications throughout California, including a Spanish-language publication. In addition, a press release in Spanish about the scoping activities was distributed to several Spanish-language radio stations. A Spanish-speaking interpreter attended each scoping meeting to solicit input.

### Technical Advisory Group

In addition to holding public scoping meetings and distributing the NOP, the SWRCB formed a technical advisory group (TAG) to provide input during preparation of the EIR and the GO. Meetings of the TAG have been held intermittently since August 1998. The TAG includes staff members of state and federal agencies (SWRCB, RWQCBs, California Department of Toxic Substances Control [DTSC], DHS, DFA, California Department of Fish and Game [DFG], IWMB, California Air Resources Board, Delta Protection Commission, EPA, U.S. Fish and Wildlife Service, and Natural Resources Conservation Service), representatives of publicly owned treatment works (POTWs) and land appliers, and representatives of special interest groups (California Farm Bureau Federation, Planning and Conservation League, California Communities Against Toxics, Association of California Water Agencies, Sierra Club, and California Environmental Health Associations).

### RWQCB Roundtable Meeting

On September 16, 1998, the SWRCB staff sponsored a roundtable meeting in Sacramento to receive direct scoping input from staff members of each of the RWQCBs. The SWRCB solicited input from the RWQCBs on the GO, alternatives to the GO, and the scope of the program EIR. The RWQCBs also were informed of their role as "responsible agencies" under CEQA and their involvement in the EIR review process. Modifications to the GO proposed by the RWQCBs were included in the revised GO. The RWQCBs also indicated how they expected to use the GO after it is adopted by the SWRCB. In addition, the location and format of the public scoping meetings were reviewed and confirmed by the RWQCBs and the SWRCB.

### Scoping Report

The NOP requested that recipients send comments on the scope of the EIR to the SWRCB to further identify issues for the EIR. The SWRCB received verbal comments from 67 individuals and letters of comment from 59 individuals or agencies. All of these comments were reviewed and a scoping report was prepared in December 1998 that summarized the proposed program, the scoping process, and issues raised during the scoping process. The report also contains all letters received and a summary of oral testimony received at the scoping meetings. A copy of the report is available for public review at the SWRCB offices in Sacramento (contact Todd Thompson at 916/657-0577) and each RWQCB office.

## Issues to Be Addressed in the EIR

Based on input received during the scoping process, the SWRCB staff determined that the following issues are of concern and should be addressed in the program EIR:

- soils, hydrology and water quality,
- land productivity,
- public health,
- land use and aesthetics,
- biological resources,
- traffic,
- air quality,
- noise, and
- cultural resources.

Potential effects on public utilities and infrastructure (other than roads), energy, geology and seismicity were not raised as concerns in the scoping process. A significant number of comments were received on the GO itself, and a number of parties recommended

adding project alternatives. All comments were considered in the development of the contents of this program EIR.

## Public Involvement

The public is encouraged to continue to be involved in the CEQA process beyond the scoping efforts. This draft program EIR is being circulated for public review and comment. In addition, the SWRCB will be conducting public hearings on the draft document. Comments received at the hearings or received in written form will be considered in the development of a final program EIR. Once the final EIR has been circulated, the SWRCB will receive public testimony on the GO before an official action is taken on its adoption or denial.

## Post-Certification Litigation

The 1999, Biosolids PEIR was challenged by Kern County, the Central Delta Water Agency, and the South Delta Water Agency. On January 13, 2003, the California Court of Appeal issued its decision and remanded the case to the trial court for issuance of a directive (i.e., a writ of mandate) to the SWRCB to vacate its approval of the GO and its certification of the 1999 Biosolids PEIR. While finding that the SWRCB generally complied with CEQA in developing and certifying the 1999 PEIR, the court concluded that two viable alternatives had been rejected without proper basis. The "in vessel composting" alternative would limit the application of biosolids to Class A biosolids only. The "crop limitation alternative" would prohibit growing fruits and vegetables on land to which biosolids would be applied. In essence, the court opined that the 1999 Biosolids PEIR improperly dismissed these alternatives based of a comparison on their effectiveness in reducing environmental impacts to the GO, as mitigated. The court determined that when compared to the GO, without mitigation, these alternatives showed promise of less impact than the proposed GO. Therefore, they should have been included among the alternatives analyzed in the 1999 Biosolids PEIR. None of the other rejected alternatives were found to warrant this level of analysis.

The trial court issued its writ of mandate in mid-August 2003 ordering the SWRCB to revise the PEIR to discuss the two alternatives. These two alternatives, entitled "Class A Only" and "Food Crop Limitation", respectively, are discussed in Chapter 14 of this revised PEIR at the same level of detail as the other primary alternatives to the proposed GO.

# Terminology

This report uses the terms "beneficial use," "reuse," and "application" interchangeably to describe the application of biosolids to land. The term "disposal" is not used to describe this activity in order to avoid confusion with the use of that term in the Part 503 regulations. Under Part 503, disposal involves the placement of biosolids on land at greater than the agronomic rate (i.e., the rate at which crops take up nitrogen). This includes placement in a landfill or a biosolids disposal facility.

This report identifies the following levels of impacts:

- a *less-than-significant* impact is an impact that is considered to cause no substantial adverse change in the environment and for which no mitigation measures are required;

- a *significant* impact is an impact that is considered to have a substantial adverse effect on the environment but for which feasible mitigation measures are available to reduce it to a less-than-significant level; and

- a *significant and unavoidable* impact is an impact that is considered to cause a substantial adverse effect on the environment and for which no feasible mitigation measures are available to reduce it to a less-than-significant level.

The program EIR also recommends mitigation measures. The State CEQA Guidelines (Section 15370) define mitigation as:

(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 affected 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 and providing substitute resources or environments.

Mitigation measures proposed in this EIR were developed to meet these requirements.

# Report Organization

The content and format of this program EIR are designed to meet the requirements of CEQA and the State CEQA Guidelines. The report is organized into the following chapters so that the reader can easily obtain information about the program and its specific environmental issues.

- The Executive Summary presents a summary of the proposed GO program and its impacts; a description of impacts and mitigation measures, presented in a table format; and impact conclusions regarding growth inducement, irreversible environmental changes, and known areas of controversy.

- Chapter 1, "Introduction", provides a brief overview of the draft EIR.

- Chapter 2, "Program Description", describes the proposed GO program.

- Chapters 3-12 are devoted to the particular issue areas identified above under "Scope of Issues to Be Addressed". Each of these chapters describes for a particular issue area the existing conditions, or setting, before project implementation, specific impacts that would result from the proposed GO program, and mitigation measures that would eliminate or reduce significant impacts.

- Chapter 13, "Cumulative Impacts", summarizes the cumulative impacts of the GO.

- Chapter 14, "Alternatives Analysis", presents the alternatives to the proposed GO (including the No-Project Alternative) and provides an evaluation of each alternative in comparison with the GO.

- Chapter 15, "Draft Mitigation Monitoring and Reporting Program", presents the CEQA-required monitoring program.

- Chapter 16, "Citations", identifies the documents used (printed references) and individuals consulted (personal communications) in the preparation of this EIR.

- Chapter 17, "Report Preparation", lists the individuals involved in preparing this EIR.

Technical appendices are included at the end of the report.

## Agencies That Will Use This Document

The SWRCB and each of the RWQCBs will use this EIR in considering their discretionary actions related to the GO program. These actions are as follows:

- The SWRCB must review the EIR before certifying it as an adequate environmental evaluation under CEQA; once the EIR is certified, it will be one of the factors considered by the SWRCB in making a decision regarding the adoption of the proposed GO.

- As responsible agencies under CEQA, the RWQCBs must ensure that the EIR addresses their environmental issues of concern; once the document is certified by the SWRCB and if the GO is approved for implementation, the RWQCBs will use the EIR as an element of the decision-making process when considering a notice of intent (NOI) filed by an individual requesting authorization for land application of biosolids under the adopted GO. If the RWQCBs find that the land application project falls within the scope of the program EIR, it can act as the CEQA compliance document for the new land application project, and mitigation measures in the program EIR will be applied to the project. If the RWQCB finds that the land application program does not fall under the scope of the program EIR, then a new initial study would need to be prepared, leading to either a project-specific negative declaration or a project-specific EIR.

## Anticipated Conditions Following Adoption of the GO

The environmental impact discussions contained in Chapters 3-12 are based on an assumed set of conditions that would follow adoption of the proposed GO. POTWs would continue to generate and treat sewage sludges in compliance with waste discharge requirements. Much of this material would be treated to meet the minimum requirements of the EPA Part 503 Regulations and the conditions of the new GO so that it could be reused in agricultural, horticultural, silvicultural or land reclamation activities as biosolids.

Biosolids would be transported to land application sites by truck and then spread on the surface of the soil or injected into the soil; most of this material would be incorporated into the soil within 48 hours of spreading onto the land. The biosolids would be used as a source of nutrients and as a soil conditioner with the intention of growing either a crop or a vegetation cover. The material would not be spread onto the land as a method of disposal, with no intention of supporting vegetation. Limitations on the frequency and volume of biosolids application on any given parcel of land would be determined by the nitrogen and metals loading limits and other restrictions contained in the GO.

The impact analysis assumed a 15-year time frame for this land application process, knowing that the SWRCB would be evaluating the success of the program over the next five years. If necessary, adjustments could be made in the regulation at any time to address longer-term impact issues.

The programmatic impact analysis is intended to address potential environmental impacts at any location in the state that is not implicitly (wetlands, waterways, urbanized areas) or explicitly (exclusion areas) exempted from the GO. Therefore, this EIR also provides programmatic analysis for the existing biosolids land application operations in the state, including the 50,000+ acres permitted under the general waste discharge requirements of the Central Valley and Lahontan RWQCBs prior to initiation of this statewide GO effort.

# Chapter 2. Program Description

# Chapter 2. Program Description

This chapter provides a description of the SWRCB's proposed GO for regulation of land application of biosolids. It also provides the reader with the setting from which the GO has been developed. The GO objectives and program description are preceded by background information on current biosolids land application in California and the regulatory framework for this activity. The full text of the proposed GO is contained in Appendix A.

## Background on Biosolids Generation, Disposal, and Reuse

### Existing and Projected Biosolids Land Application in California

The methods available for biosolids management, and particularly land application of biosolids, are largely determined by the quality of the generated product. Sewage sludges removed in municipal wastewater treatment plants can be treated to produce biosolids of sufficient quality for use as soil amendments or can be disposed of. The three primary methods for reuse and disposal of biosolids are land application, surface disposal in a landfill, and incineration. This section describes the existing quantity of biosolids generated at municipal POTWs in California and the distribution of those biosolids to different reuse and disposal options. The projected quantity and distribution of biosolids are discussed with respect to a long-term planning horizon suitable for evaluation in this program EIR.

#### Current Biosolids Activity in California

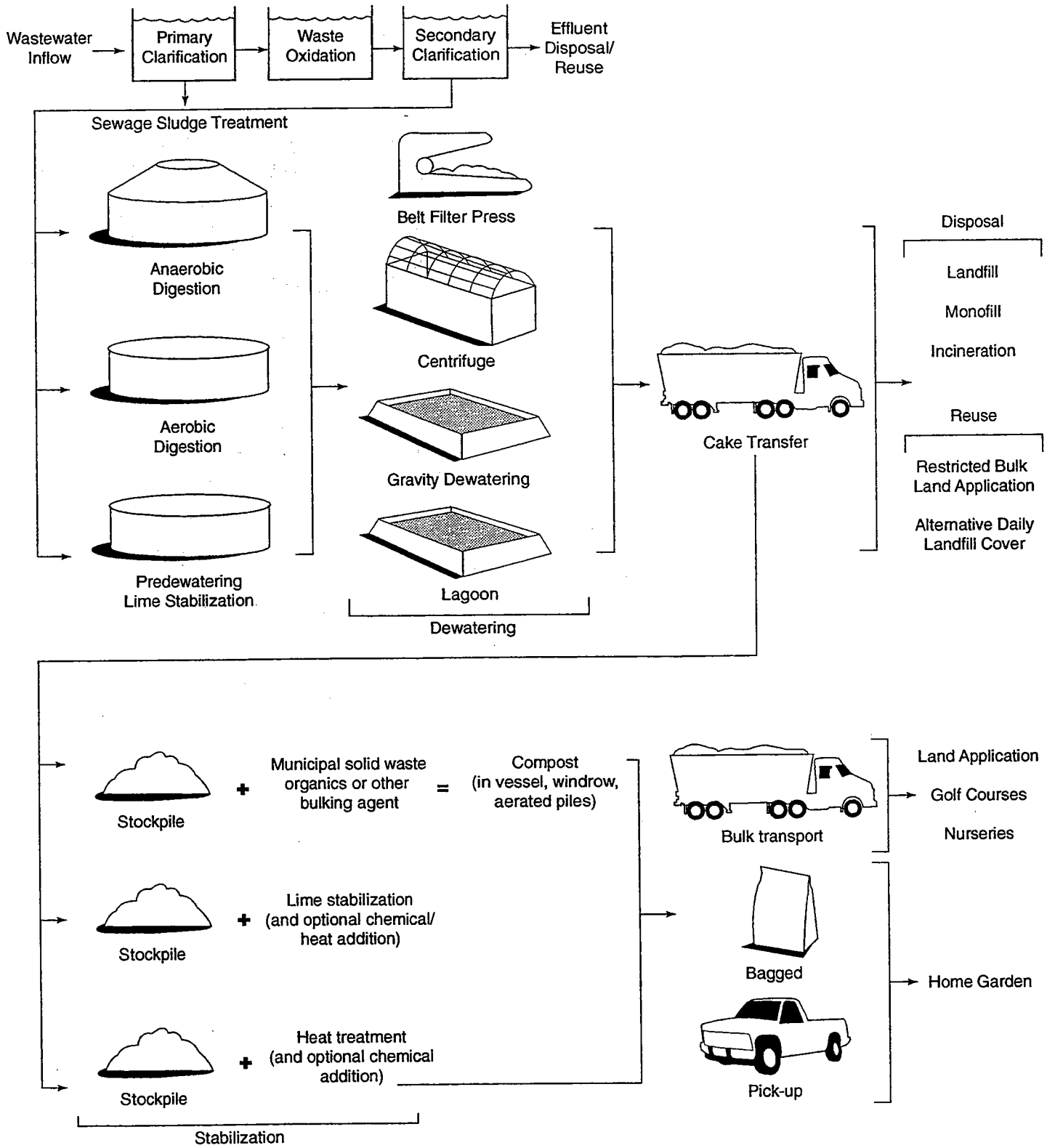
**Typical Biosolids Treatment.** The quantity of biosolids generated at a municipal POTW depends on the specific processes for waste treatment and solids thickening that are used and the volume of wastewater received. The water content and appearance of the biosolids can differ depending on the ultimate disposal or reuse option used. Figure 2-1 shows treatment processes used to treat sewage sludge to produce biosolids at a POTW. Biosolids are separated from the liquid fraction of the waste stream at a typical POTW by primary and secondary clarification following waste oxidation processes. Following clarification, biosolids are commonly stabilized by anaerobic digestion, aerobic digestion, or pre-dewatering lime stabilization to reduce the level of pathogens and attraction to disease vectors such as flies, rodents, and mosquitos. Once stabilized, the moisture level of the biosolids may be reduced by mechanical filter

presses or centrifuges, gravity dewatering, heat treatment, solar drying, or long-term lagoon storage. After this initial treatment, biosolids can be disposed of in landfills. If pathogen levels and vector attraction have been sufficiently reduced following stabilization and drying, biosolids may then be used as daily cover at landfills; incinerated; or applied in bulk for certain types of agriculture, silviculture, or land reclamation. Alternatively, additional biosolids treatment may be employed (e.g., composting, lime stabilization, heat treatment, and thermophilic digestion) to further reduce pathogen levels and vector attraction. This additional treatment allows for more limited horticultural uses, such as bulk and bagged sales to the public as a garden soil amendment, bulk land application to public areas (e.g., golf courses and parks), and land application for certain agricultural crops.

**Quantity of Biosolids Generated.** The California Association of Sanitation Agencies (CASA), a nonprofit organization of municipal utilities, conducted statewide surveys in 1988, 1991, 1999 and 2001 to estimate the quantity of biosolids currently generated and the uses of those biosolids (California Association of Sanitation Agencies 1991, 1999, 2001). A portion of the large increase in dry TPD between the 1998 and 2001 surveys may be attributed to a larger survey sample of POTWs and higher rate of response to the survey. The 1988 and 1991 CASA survey results are derived from a database of 120 POTWs in California. CASA received responses from 86% of the POTWs in the 1988 survey and received updated responses from 45% of the POTWs in 1991. The 2001 CASA survey results are derived from a database of 197 POTWs, and the response rate is approximately 97% of the total. If complete information was not submitted with the survey response forms, CASA did not include the results in the summary analyses and quantitative estimates of biosolids management practices.

Based on the positive responses, CASA concluded that daily biosolids generation was 1,025 dry tons per day (TPD) in 1988; 1,610 dry TPD in 1991; 1,842 dry TPD in 1998; and 5,884 dry TPD in 2001. More than 70% of this material is generated at 10 POTWs that have daily wastewater flows in excess of 50 million gallons per day (mgd). Figure 2-2 shows the regional distribution of biosolids production within each RWQCB region, which is generally similar in all the surveys. As shown in Figure 2-2, the Los Angeles region generates the greatest percentage (nearly 40% in 1998) of biosolids among the nine RWQCB areas, followed in order by the Central Valley, San Francisco, Santa Ana, and San Diego regions.

**Quantity of Biosolids Generated.** The California Association of ~~Sanitary~~Sanitation Agencies (CASA), a nonprofit organization of municipal utilities, conducted statewide surveys in 1988, 1991, and 1999 to estimate the quantity of biosolids currently generated and the uses of those biosolids (California Association of ~~Sanitary~~Sanitation Agencies 1991, 1999). The 1988 and 1991 CASA survey results are derived from a database of 120 POTWs in California. CASA received responses from 86% of the POTWs in the 1988 survey and received updated responses from 45% of the POTWs in 1991. Information from the 1998 survey is still being compiled, but it is derived from a 66% response. If complete information was not submitted with the




SOURCE:
Modified from Carollo Engineers 1997.

Jones & Stokes Associates, Inc.

**Figure 2-1**
**Typical Biosolids Management Practices**

survey response forms, CASA did not include the results in the summary analyses and quantitative estimates of biosolids management practices.

Based on the positive responses, CASA concluded that daily sludge generation was 1,025 dry tons per day (TPD) in 1988; 1,610 dry TPD in 1991; and 1,842 dry TPD in 1998. More than 70% of this material is generated at 10 POTWs that have daily wastewater flows in excess of 50 million gallons per day (mgd). Figure 2-2 shows the regional distribution of sludge production within each RWQCB region, which is generally similar in all three surveys. As shown in Figure 2-2, the Los Angeles region generates the greatest percentage (nearly 50%) of sludge among the nine RWQCB areas, followed in order by the Central Valley, San Francisco Bay, and Santa Ana regions.

**Disposal and Reuse Methods.** Biosolids reuse and disposal options as a percentage of total biosolids generated in California are shown in Figure 2-2. The 1988 estimates indicated that approximately 60% of the biosolids generated in California were disposed of in landfills; the percentage decreased to approximately 45% by 1991. Land application and composting accounted for 18.7% and 21.7%, respectively, of the biosolids reuse in 1991, and both uses had increased considerably from what was reported in 1988. The combined onsite storage and incineration of biosolids remained stable from 1988 to 1991 at approximately 14% of the total generated quantities. The 1998 information indicates a huge increase in land application, with nearly 68% of the material reported through the survey going to this reuse option. As a result, the percentage being disposed of in landfills was reduced to 9.1%. Incineration was the selected method of disposal for 5.6%, and 6.9% remained in onsite storage.

The 2001 information is currently incomplete, however the data available suggests an increase in landfill disposal of biosolids.

In 2003, CASA prepared an estimate of the volume of biosolids use as of 2001, based on data reported to the EPA. The 2001 estimates indicated that approximately 48% of the biosolids generated in California were land applied; and approximately 18% was disposed of in landfills. Incineration accounted for approximately 2.4% of the biosolids and approximately 1% was kept in onsite storage. (California Association of Sanitation Agencies 2003) The marked decrease in the relative amount being land applied probably reflects the restrictions on land application adopted by counties in the Southern San Joaquin Valley after 1998.

Most of the biosolids being ~~reused~~beneficially used in California are generated in the ~~Los Angeles and Orange County areas~~southern counties, as well as in the other large urban centers ~~of~~such as the ~~state (San Diego, the San Francisco~~ Bay Area, ~~Sacramento)~~. Much of this material is transported ~~a considerable distance~~ by truck to agricultural areas for land application. Table 2-1 identifies the ~~location and volume~~major sources of biosolids applied to land in ~~1998~~2001 by county, and Table 2-2 identifies the distribution of production by RWQCB region. The counties ~~supporting~~producing the largest amounts of biosolids ~~reuse~~

~~are Kern, Kings, Merced, San Diego~~in 2001 were Los Angeles, Riverside, San Bernardino, and ~~Solano~~Orange.

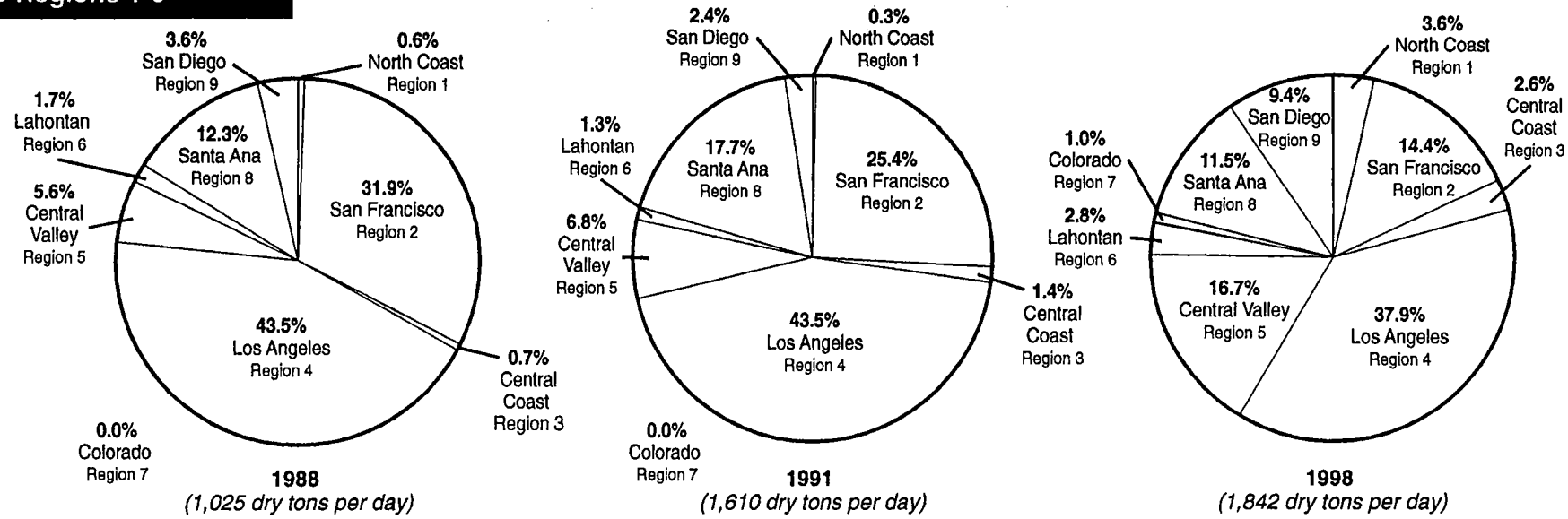
The CASA biosolids surveys did not ask the POTWs to specify whether their land application practices included agriculture, horticulture, silviculture, land reclamation, or home garden uses. In general, however, the most common land application practice is spreading and incorporation into agricultural land (California Water Environment Association 1996). Much smaller quantities are used in composting operations for eventual horticultural use and in land reclamation. Little or no material is currently being used to support silvicultural practices in California.

**Agricultural Use.** Figure 2-3 shows an example of a land application site for agricultural crop production, including staging (or temporary stockpiling of biosolids) at the farm, loading and spreading of biosolids, and incorporation practices. In agricultural use situations, biosolids are usually transported from the POTW of origin to the agricultural site in bottom-dumping trailers. When the material is received at the agricultural site, it may be dumped directly in long windrows on the fields, bottom-dumped into spreaders for immediate application, or placed in stockpiles for later transfer into spreaders. The biosolids are spread evenly across the fields and subsequently incorporated into the bare soil through disking or harrowing. In some instances, biosolids with a high moisture content may be transferred to liquid tank vehicles and injected into the soil (see Figure 2-3). Individual fields may receive one or several loads of biosolids before a crop is planted.

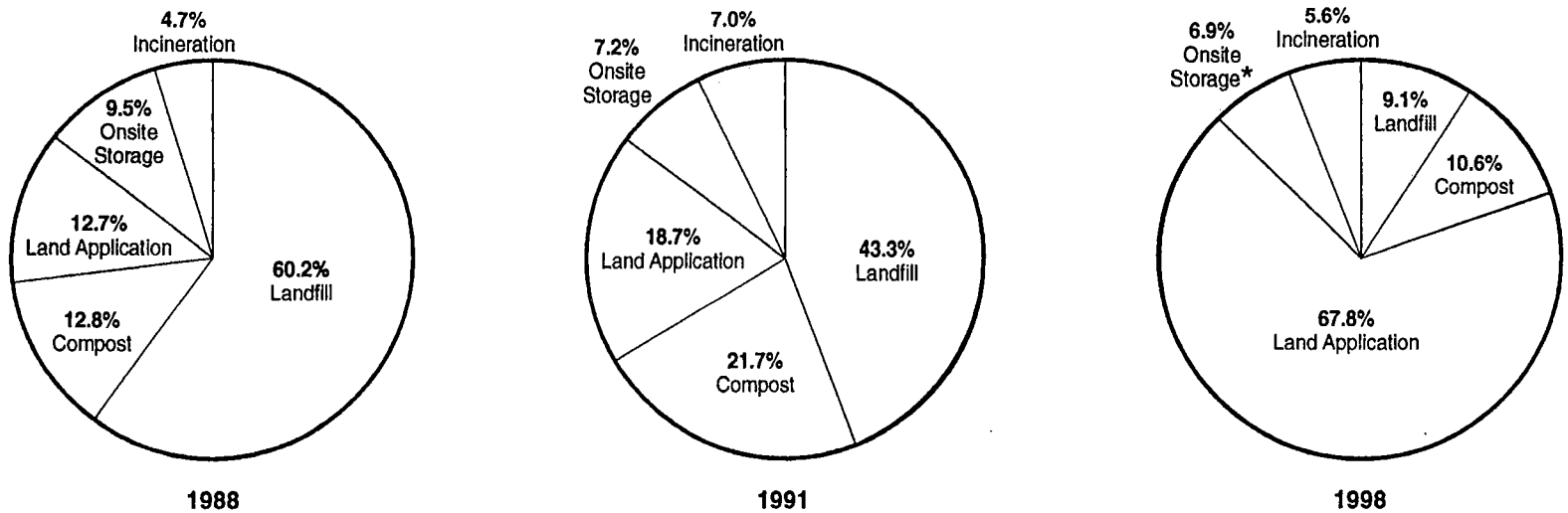
**Horticultural Use.** In California, horticultural use typically involves Class A Exceptional Quality biosolids (defined below in "Discharge Specifications") that have been composted with various types of green waste. Following the composting process, the biosolids may be packaged or made available to the public in bulk for home garden use. The GO is not intended to regulate these small-scale uses. The material is also used by various state and local entities and private businesses for large-scale landscape plantings such as road medians, parks, ornamental flower production, landscape and turfgrass production, and golf courses. It may also be used as a planting or potting medium in large nursery operations. Horticultural use areas are generally much more accessible to the public and involve a larger work force than do agricultural operations.

**Silvicultural Use.** Currently, no large-scale silvicultural uses of biosolids are under way in California. Silvicultural uses are common in other parts of the country, however, including the Pacific Northwest. A typical silvicultural operation would include transfer of biosolids by truck from the POTW to a commercial tree-growing operation. The material would be transferred to a hopper vehicle equipped with an impeller spreader for application. The land itself may be totally cleared or it may have trees already growing. The biosolids may or may not be mechanically incorporated into the soil, depending on the existing groundcover and site slopes. In some instances, liquid biosolids have been sprayed onto silvicultural sites.

## Quantity of Biosolids Generated in RWQCB Regions 1-9




## Distribution of Biosolids Reuse and Disposal




SOURCE:
California Association of Sanitation Agencies 1999.

* Onsite storage for this year only combines onsite and offsite storage and surface disposal.

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**Figure 2-2**
**Distribution of Biosolids Generated in California (1988, 1991, and 1998)**

## Table 2-1.
## Sources of Biosolids in California in 2001

| County | Biosolids Quantity (dry tons per year) |
|---|---|
| Alameda | 124,389 |
| Contra Costa | 14,036 |
| El Dorado | 2,211 |
| Fresno | 27,530 |
| Humboldt | 1,455 |
| Imperial | 343 |
| Kern | 38,677 |
| Kings | 1,267 |
| Lassen | 107 |
| Los Angeles | 413,258 |
| Madera | 771 |
| Marin | 1,562 |
| Mariposa | 290 |
| Mendocino | 799 |
| Merced | 2,462 |
| Monterey | 1,558 |
| Napa | 6,379 |
| Nevada | 1,007 |
| Orange | 86,710 |
| Riverside | 153,239 |
| Sacramento | 2,287 |
| San Bernadino | 108,465 |

# Table 2-1. Continued



| | |
|---|---|
| San Diego | 35,368 |
| San Joaquin | 24,550 |
| San Luis Obispo | 7,862 |
| San Mateo | 7,162 |
| Santa Barbara | 14,437 |
| Santa Clara | 715 |
| Santa Cruz | 3,870 |
| Shasta | 1,781 |
| Solano | 28,172 |
| Sonoma | 10,174 |
| Stanislaus | 17,060 |
| Tulare | 11,639 |
| Tulomne | 347 |
| Ventura | 53,413 |
| Yolo | 1,447 |
| Yuba | 84 |
| Total | 1,206,883 |

Sources: California Association of Sanitation Agencies 2001.

# Table 2-2.
# Quantities of Biosolids Generated in California by RWQCB in 2001

| Regional Board | Biosolids Quantity (dry tons per year) |
|---|---|
| North Coast | 2,255 |
| San Francisco | 192,590 |
| Central Coast | 27,727 |
| Los Angeles | 470,980 |
| Central Valley | 133,411 |
| Lahontan | 4,890 |
| Colorado River | 153,582 |
| Santa Ana | 190,392 |
| San Diego | 31,057 |
| Total | 1,206,883 |

Sources: California Association of Sanitation Agencies 2001.

## Table 2-2a
## Application of Biosolids to Agricultural Lands by Crop Type, 2001

**Food Crops (from EPA data disk)**

| Crop Type | Acres Applied | % of Total |
|---|---|---|
| Pumpkins | 13 | 0.02 |
| Walnuts | 29 | 0.05 |
| Safflower | 560 | 0.96 |
| Corn (Grain) | 2,706 | 4.65 |
| Wheat | 54,825 | 94.3 |

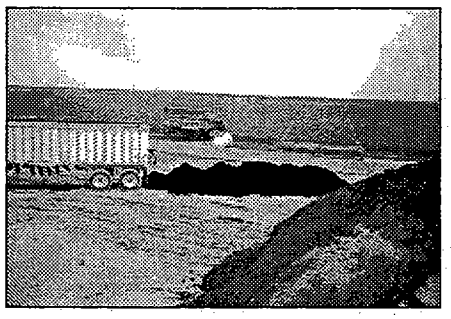
Total Acres Applied to Food Crops: 58,133

**Non-Food Crops**

| Crop Type | Acres Applied | Tons/Acre Applied | % of Total |
|---|---|---|---|
| Alfalfa | 7,415 | N/A | 9.9 |
| Barley | 1,922 | N/A | 2.56 |
| Bermuda Grass | 185 | N/A | 0.25 |
| Cotton | 7,428 | N/A | 9.92 |
| Corn /Silage | 11,689 | N/A | 15.6 |
| Hay | 145 | N/A | 0.2 |
| Milo | 4,480 | N/A | 5.98 |
| Oats/Oat Hay/Sorghum | 760 | N/A | 1.01 |
| Pasture | 16,874 | N/A | 22.5 |
| Rye Grass/Mix | 23,687 | N/A | 31.6 |
| Sudan | 298 | N/A | 0.4 |

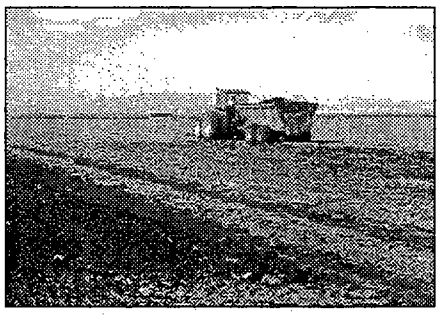
Total Acres Applied to Non-Food Crops: 74,883

Source: U.S. Environmental Protection Agency, Office of Water. Biosolids Database Management System. Washington, D.C. November 2003.

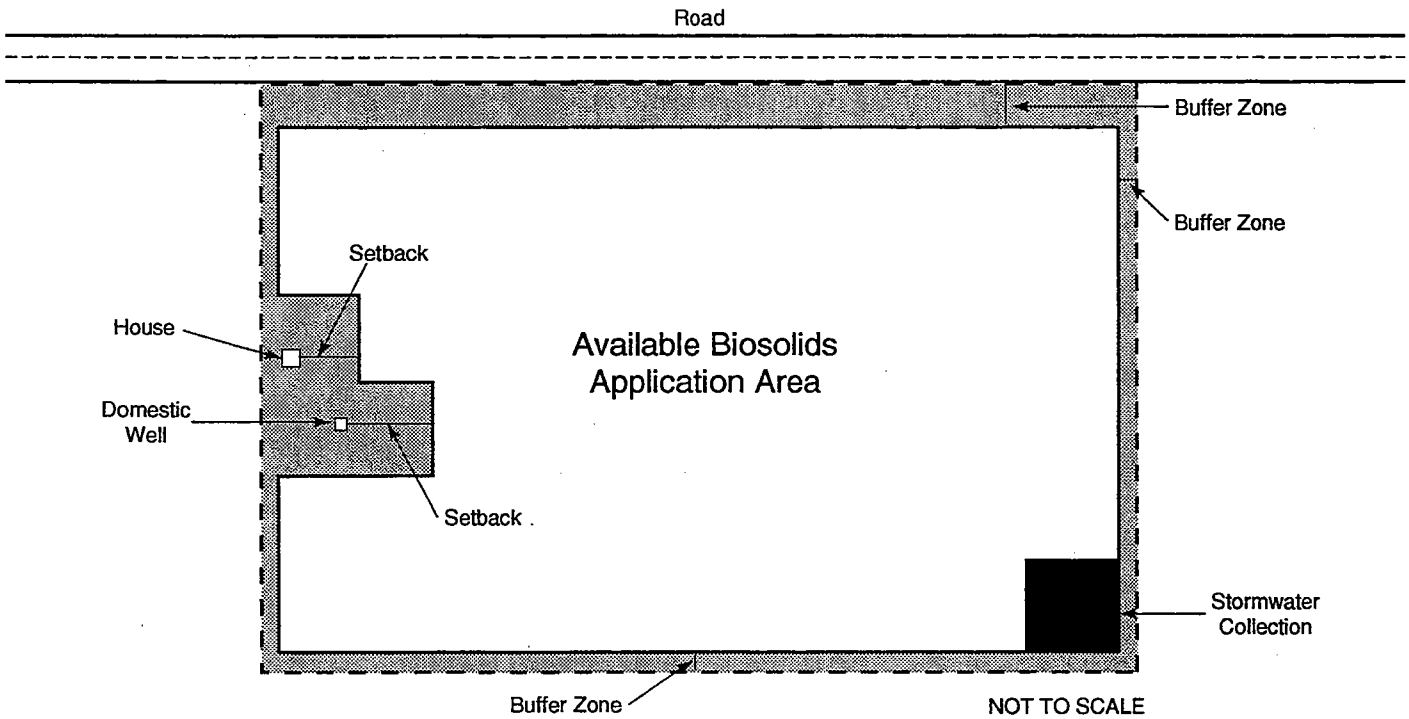


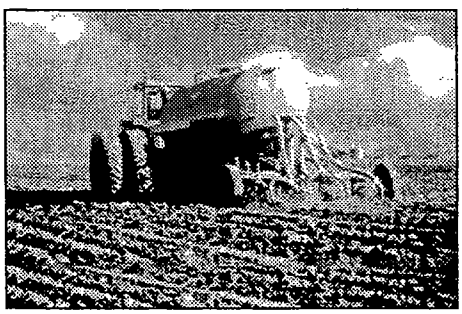
Biosolids staging at farm

Loading spreader

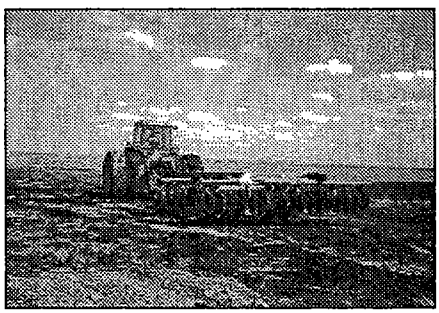


Land application by spreader



Land application by injection



Incorporation of biosolids into soil

SOURCE:
Carollo Engineers 1997. Photographs provided by the Merriwood Corporation and QUAD Consultants.

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**Figure 2-3**
**Typical Biosolids Land Application Site**

**Land Reclamation.** Land reclamation is not currently a major biosolids reuse option in California. The major use that would fall into this category is incorporation into final cover material at landfills. This use is not considered a disposal method because it is intended to increase the productivity of the cover soils. Other uses could include incorporation into surface materials at mining reclamation sites or soil borrow areas where subsoil material with low growing potential is exposed at the surface. Large-scale reclamation uses (i.e., for use in areas of more than 20 acres) are likely to occur in rural areas rather than urban settings because landfills and mining operations are typically not compatible with urban environments.

## Future Biosolids Production and Use in California

Future biosolids production can be estimated based on population projections and estimated per capita generation rates. Statistics ~~were~~ compiled from the California Department of ~~Finance~~Finance's Demographic Research Unit and CASA ~~for~~are used in this EIR~~. The California~~ to make a broad estimate of the amount of biosolids that will be produced as California's population increases over time. This estimate does not distinguish between urban and rural population, although rural populations are generally not served by wastewater treatment plants and would not contribute to the total production of biosolids. The estimate assumes that the relative percentage of urban/rural residents will remain the same into the future. As a result, the following may underestimate future production if the general trend of increasing urbanization of the State's population continues.

Based on the Department of ~~Finance tracks and prepares reports on various population trends and regional distribution statistics. The use of census information to estimate biosolids generation must discriminate between rural and urban areas because urban areas are more likely to be served by municipal sewer and wastewater treatment systems. Based on census information, the population in urban areas in 1990 (when the last CASA survey was completed) was 29.8 million~~Finance's estimate, California's population in 2001 (the date of the latest CASA estimate of biosolids production) was approximately 34.37 million people. (California Department of Finance~~1998a~~2003), ~~and t~~This ~~figure~~number is ~~expected~~projected to increase ~~by~~to approximately 4~~2~~5.~~3% to 42.4~~8 million people by ~~2015~~2020. (California Department of Finance ~~1998b~~2001). Based on the ~~1991~~2001 CASA estimate of biosolids generation (~~1~~5,~~610~~884 dry TPD) and assuming ~~that~~ the rate of per capita biosolids generation remains similar until 20~~15~~20, the total estimated production of biosolids is expected to increase to ~~2,329 dry TPD. If the percentage of biosolids that are land applied remains constant in the next 15 years, the amount of material being land applied would be 1,579 dry TPD in 2015, with an annual total of 576,690 dry tons~~approximately 7,840 dry TPD.

Reuse and disposal practices in California have changed over the years, as can be seen in the differences between the 1988 and 1998 CASA surveys. Consequently, it is difficult to predict how the additional biosolids generated in California will be used and disposed of in the future. The costs of all treatment and disposal options are likely to increase as land values and regulatory controls increase. The future disposal destinations of biosolids will also be affected by available space in landfills, public perception and government policies toward

acceptable uses of biosolids, and new information developed by the scientific community. Given that biosolids generation will increase substantially along with the state's population, it is clear that the demand for land application sites will increase as well.

# Existing Regulatory Programs

The principal regulatory programs that currently have an influence over biosolids disposal and use include the RWQCB implementation of water quality protection programs under the Clean Water Act and California Porter-Cologne Water Quality Control Act, implementation of the federal Part 503 regulations for biosolids management by EPA, and local control of waste disposal at the county level through ordinances and land use regulations. A more detailed description of these and other, less influential state programs is contained in Appendix C.

## State Programs—Role of RWQCBs

In California, the land application of biosolids by individuals or parties not involved in biosolids generation is currently regulated primarily through the issuance of waste discharge requirements (WDRs) by the individual RWQCBs in accordance with Section 13260 of the Porter-Cologne Water Quality Control Act. Existing biosolids land application projects have been permitted with individual WDRs issued in several of the nine RWQCB regions. The WDR process requires a potential discharger of biosolids to prepare a Report of Waste Discharge that describes the biosolids application project in detail. The RWQCB then evaluates the project and prepares WDRs that specify discharge conditions, prohibitions, and monitoring and reporting requirements for the project. The RWQCBs often make the WDR process contingent on the project's adherence to the federal Part 503 regulations. Several RWQCBs have adopted waivers for WDR preparation if the biosolids application project would involve biosolids with low pollutant and pathogen concentrations, as specified in the Part 503 regulations (see details below under "Discharge Specifications").

## Federal Programs—Part 503 Regulations

The federal regulatory program for biosolids land application is based on the Part 503 regulations. These regulations are overseen by EPA and are considered self-implementing. No site permit is issued for the land application of biosolids. Instead, permits are issued to the biosolids generator. Part 503 restrictions and conditions are typically included in the National Pollutant Discharge Elimination System (NPDES) permit issued by the RWQCB for the operation of a POTW. The Part 503 regulations establish limits for pollutant levels;

operational standards and management practices; and monitoring, record keeping, and reporting requirements. The Part 503 regulations are applicable to projects that generate sewage sludge to produce biosolids or material derived from biosolids. The following section describes the details of the Part 503 regulations as they apply to land application of biosolids.

## Discharge Specifications

EPA developed the Part 503 regulations to primarily protect the public and agricultural productivity. An emphasis was placed on persons who are extensively exposed to biosolids material (primarily POTW operators and persons applying biosolids to the land), from pathogens and pollutants. The Part 503 regulations establish two pathogen reduction standards for land-applied biosolids: Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed. Class A biosolids must be monitored for bacteria growth at the time of use. Land application of biosolids that meet Class B criteria are restricted by the following conditions:

- food crops with harvested parts that touch the soil and are totally above the soil cannot be harvested for 14 months,
- food crops with harvested parts below the soil cannot be harvested for 20 months if biosolids remain on the land surface for at least 4 months before being incorporated into the soil,
- food crops with harvested parts below the soil cannot be harvested for 38 months if biosolids remain on the land surface for less than 4 months before being incorporated into the soil,
- feed and fiber crops cannot be harvested for 30 days after biosolids application,
- animals cannot be grazed on the site within 30 days of biosolids application,
- turf cannot be harvested for 12 months if the site would have a high potential for public exposure,
- public access is not allowed for 12 months to land with high potential for public exposure, and
- public access is not allowed for 30 days to land with low potential for public exposure.

Part 503 regulations for reducing vector attraction specify several alternative treatment processes and management practices that the biosolids must undergo. Vectors are pests such as flies, mosquitos, and rodents that can be attracted to incompletely treated biosolids

and could transmit diseases to other organisms. Biosolids must be treated to at least Class B level for pathogen and vector reduction levels to be land applied.

The Part 503 regulations establish minimum standards for concentrations of nine pollutants in biosolids that are to be applied to land (Table 2-3). Biosolids are considered Class A Exceptional Quality (EQ) if they meet all of the pollutant concentration limits and vector attraction reduction options 1-8 in Part 503.88, as well as Class A pathogen reduction standards. EQ biosolids can be distributed in bulk or packaged and are not subject to general management practices other than monitoring and reporting to confirm that the criteria have been met. Class A biosolids that contain any one of the nine pollutants (Part 503, Table 1) in concentrations exceeding the pollutant concentration limits for EQ biosolids, but that are below the ceiling limits, can be applied to land but are subject to cumulative and annual pollutant loading restrictions depending on their intended use, as shown in Table 2-3. Class A biosolids with all pollutants below the pollutant concentration limits for EQ biosolids can be applied without loading rate restrictions. If the biosolids contain any of the listed pollutants at concentrations that exceed the ceiling concentration limits, they cannot be applied to land.

## Other Policies and Procedures

The Part 503 regulations specify several standard conditions that must be followed for site management; distribution and marketing of biosolids products; and monitoring, record keeping, and reporting procedures. If biosolids do not meet EQ standards, those general management practices that are specified include the following:

- biosolids cannot be applied to a site if doing so is likely to affect a threatened or endangered species;
- biosolids must not be applied to frozen, snow-covered, or flooded ground; and
- biosolids cannot be applied to land within 10 meters (33 feet) of a surface water body.

In some cases, the Part 503 regulations contain specific requirements for labeling of biosolids materials and products to be marketed, sold, or given away. The label must contain the name of the person or agency that prepared the biosolids, statements of land application prohibitions with respect to pollutant limits, and loading rates. The required monitoring frequency is determined based on the quantity of biosolids generated at the POTW. Monitoring can vary from once per year for small operations to monthly for large POTWs. A report must be submitted to EPA once per year and monitoring records must be kept for 5 years.

The EPA does not take an active role in inspecting sites to which biosolids are applied for compliance with the Part 503 regulations. The EPA's Office of the Inspector General issued a status report on the Land Application of Biosolids in March 2002 in response to a series

## Table 2-3.
## Regulatory Pollutant Concentrations and Loading Rates under Part 503 Regulations

| Pollutant | Pollutant Concentration in EQ Biosolids (mg/kg) | Ceiling Concentration in Biosolids Applied to Land (mg/kg) | Cumulative Pollutant Loading Rate Limits (kg/ha) | Annual Pollutant Loading Rate (kg/ha/yr) |
|---|---|---|---|---|
| Arsenic | 41 | 75 | 41 | 2 |
| Cadmium | 39 | 85 | 39 | 1.9 |
| Copper | 1,500 | 4,300 | 1,500 | 75 |
| Lead | 300 | 840 | 300 | 15 |
| Mercury | 17 | 57 | 17 | 0.85 |
| Molybdenum | -- | 75 | -- | -- |
| Nickel | 420 | 420 | 420 | 21 |
| Selenium | 100 | 100 | 100 | 5 |
| Zinc | 2,800 | 7,500 | 2,800 | 140 |
| Applied to: | Bulk biosolids and bagged biosolids | All biosolids that are land applied | Bulk non-EQ biosolids | Bulk biosolids |

Notes: mg/kg = milligrams per kilogram.
kg/ha = kilograms per hectare.
kg/ha/yr = kilograms per hectare per year.

Sources: Pollutant concentration in EQ biosolids—Part 503, Table 3; ceiling concentration in biosolids applied to land—Part 503, Table 1.

of allegations by the National Whistleblower Center (a non-governmental agency) that EPA's biosolids oversight is lax. The status report found that the EPA has not fully funded biosolids program staff, the program for delegating biosolids responsibility to the states has not been adequately funded and few states have chosen to join, the EPA does not have a central system for responding to and tracking health complaints and generally considers such complaints to fall outside its jurisdiction, the EPA has not updated its methodologies for risk assessment and pathogen testing, and EPA could do a better job responding to public perceptions of biosolids being a health concern.

For the most part, these issues are outside the PEIR's area of concern. The proposed GO would assert state authority over the application of biosolids to land. As such, it would provide for regulatory oversight of beneficial use by the SWRCB and individual RWQCBs. Because the GO incorporates requirements that are more stringent than those in the Part 503 regulations, the shortcomings of EPA oversight are not pertinent.

On December 31, 2003, the EPA announced in the Federal Register its final action plan in response to the NRC recommendations arising from the Biosolids Applied to Land report. This response addresses the above issues. (Federal Register, Volume 68, page 75531) For a more detailed discussion of the final action plan, see Chapter 5 of this EIR.

## Local Programs—County Ordinances

Several California counties have adopted local ordinances that directly regulate biosolids reuse and disposal practices or indirectly affect biosolids management by requiring conditional use permits for certain activities. The local ordinance adoption process could affect the implementation of permitting procedures under the GO. RWQCB staff engineers and reviewing agencies would need to be aware of local permit requirements and conditions of local ordinances to assess the applicability of the GO to specific projects.

Of the 58 counties in California, ~~16~~ 17 currently have ordinances that relate directly to land application of biosolids. Three counties have outright bans on land application, ~~seven~~ nine have effective bans (their ordinances are so restrictive that they effectively discourage land application), and five allow regulated use. The remaining ~~42~~ 41 counties without ordinances rely on the RWQCBs to regulate land application through the WDR process. These local ordinances are important because they restrict the areas within the state that can currently accommodate land application of biosolids, and they supercede the controls of the proposed GO where they are more restrictive.

# General Order Program Objectives

The goal of the GO is to provide a clear and consistent regulatory process that is adequately protective of environmental resources, streamlines the permitting process for land application of biosolids, and includes policies and procedures that ensure continued refinement of biosolids disposal practices and protection of the environment. Therefore, the GO is intended to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on NOIs filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids disposal program for land application operations at the regional level and contains requirements that are based on sound science and best professional judgment.

Each of these program objectives is described below.

## Comply with California Water Code and Judicial Order

The first objective of the GO, to provide a statewide regulatory program, is based on the need to comply with Section 13274 of the California Water Code, which requires the issuance of WDRs for projects that may affect waters of the state, and to respond to the legal challenges brought against the individual GOs proposed by the Central Valley RWQCB. In particular, any proposed program must be applicable on a statewide basis because biosolids generated within one region may be applied in a different area. In addition, resource protection factors specific to California that are not addressed through the Part 503 regulations must be incorporated into a statewide regulation.

The existing process of individually issuing WDRs for land application of biosolids could lead to inconsistencies between regions that may affect the feasibility, operation and maintenance procedures, and costs of land application. Consequently, a statewide regulation must promote an effective statewide permitting process to minimize inconsistent regional permitting requirements.

## Provide Regulatory Framework for RWQCB Permit Process

The objective of creating a cost-effective regulatory framework is a critical aspect of streamlining the RWQCBs' processes for biosolids management, CEQA review, and permitting. The current process (individual review and issuance of WDRs and the corresponding CEQA environmental review requirements implemented by each RWQCB) requires a substantial expenditure of resources by regulatory agencies and other involved parties. The federal Part 503 regulations are developed using environmental risk exposure models to ensure that the regulatory criteria cover a wide range of environmental conditions under which biosolids may be applied. Consequently, for most land application projects, the regulatory framework should allow for streamlined permit and CEQA review and approval procedures if the threat of adverse environmental effects is determined to be negligible. The approach of establishing a general order provides each RWQCB with objective screening criteria against which to evaluate each NOI and through which routine land application projects can be expedited. The regulatory program must also provide objective criteria and guidelines under which each RWQCB can implement additional review or develop supplemental permit conditions if these are found to be necessary to ensure environmental compliance.

## Provide Flexible Regulatory Framework

The third objective of the GO is to provide a regulatory setting that uses the environmental risk-based analyses developed for the Part 503 regulations or an equivalent analysis so that the program is adequately protective of the environment. A program that has statewide application and involves complex pollutant management issues must be based on thorough scientific justification. In addition, the regulatory program must be responsive to new scientific evidence relating to biosolids and allow for incorporation of new practices and procedures if the scientific community determines that changes are necessary. Areas of controversy are the safety of land application of biosolids, the applicability and level of protection afforded under the federal Part 503 regulations, and the efficacy of the GO regulatory framework in the evaluation and protection of site-specific resources. Therefore, any proposed regulation related to biosolids land application should include mechanisms that allow for incorporation of future management practices that are determined to better protect environmental resources or improve the regulatory and permitting process.

# Description of General Order

## Overview

The proposed GO was developed to provide a single regulatory framework for the land application of biosolids in California and to streamline the permitting process that each RWQCB uses for biosolids application projects. Provisions of the GO were based largely on the federal Part 503 regulations to ensure that the state regulation incorporates the extensive health risk assessments and scientific review that went along with developing the federal regulation. Baseline criteria that were established under the Part 503 regulations must be met under the GO and associated general WDRs. Projects that fail to meet the criteria established by the GO may still apply for an individual permit from the RWQCB. This section generally describes the principal permit conditions and procedures of the GO.

## Applicability

For the purposes of the GO, *biosolids* are defined as only those sewage sludges produced at municipal wastewater treatment plants that meet the requirements of the Part 503 regulations. Unstabilized sewage sludge, septage, and wastes that do not meet the Part 503 regulations or are determined to be hazardous under Title 22, Division 4.5, Chapter 11, Article 3 of the CCR would not be regulated under the GO.

Under the GO, the *discharger* is defined as primarily the landowner and generator, but could also include any individual, business, or organization involved in the transportation, use, and application of biosolids. The discharger would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land that receive biosolids, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project must file a separate NOI, pay a separate filing fee, and list each generator associated with the proposed operation as co-dischargers. A permitted project applicable to the GO may involve a single application of biosolids or repeated applications. The identification of permitted activities under the GO does not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse. The discharger is responsible for making inquiries about permitted uses and obtaining applicable local permits and authorizations.

An important component of the GO is the requirement that each biosolids application project operator, before applying any biosolids, must prepare and submit an NOI for the area in

which the biosolids are to be applied. The appropriate RWQCB would then review information contained in the NOI and, if it finds the information to be adequate, issues a Notice of Applicability under the general WDRs of the GO along with discharge monitoring requirements. A complete NOI includes a preapplication report that provides the RWQCB with specific information relating to each field or distinct application area, including:

- contact personnel;
- project location;
- map that shows site topography and elevation; staging/storage and application areas; and nearby residences, roads, surface waters, and groundwater wells;
- source and chemical test results for biosolids;
- description of proposed application area, application practices, and type of crops to be grown;
- spill response plan; and
- any applicable erosion control, biosolids storage, and groundwater monitoring plans that would be required under the GO.

An annual filing fee is required for each year that the project is operating and is based on the threat to water quality and complexity of the project as identified in 23 CCR 2200. Biosolids projects encompassing an area of 40-2,000 acres would be designated a Category II threat to water quality and given a Category "b" complexity rating. Biosolids projects of less than 40 acres would be classified a Category III threat to water quality and given a Category "b" complexity rating.

## Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program:

- Biosolids must be treated to reduce potential disease-causing pathogens.
- Class A biosolids have been treated sufficiently that pathogens are essentially eliminated; Class A biosolids must be monitored for bacteria growth at the time of use.

- Class B biosolids have been treated sufficiently that pathogens are substantially reduced, but not completely eliminated. Land application of biosolids that meets Class B criteria is restricted by the following conditions:

  - food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;

  - food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;

  - food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;

  - food and fiber crops cannot be harvested for 30 days after biosolids application;

  - animals cannot be grazed on the site within 30 days of biosolids application;

  - turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);

  - public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application; and

  - ~~grazing of milking animals used for producing unpasteurized milk for human consumption is prevented for at least 12 months if the field is used as pasture; and~~

  - public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes and management practices that the biosolids must undergo to reduce vector attraction. Biosolids must be treated to meet at least Class B criteria for pathogen reduction and vector reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of 10 metals, nine of which are regulated under the Part 503 regulations (see the discussion below in “Discharge Prohibitions” and “Discharge Specifications”). Restrictions on pollutant addition levels are described above in “Discharge Specifications”.

## Discharge Prohibitions of the GO

The GO contains prohibitions that apply to all land application projects that request authorization. In general, biosolids must not be applied under the following conditions:

- the biosolids to be discharged cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;
- the biosolids cannot be discharged except as allowed at authorized storage, processing, and land application sites;
- no application is permitted until the RWQCB has issued a Notice of Applicability, a set of individual WDRs, or a waiver of WDRs;
- no application is permitted if the discharge would cause or threaten to cause pollution or create a nuisance as defined by Section 13050 of the California Water Code;
- no application is permitted that would cause a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5);
- no application is permitted to areas not specified in the applicant's NOI;
- no application is permitted to surface waters or drainage courses;
- no application is permitted when the application rate would exceed the nitrogen requirements of the vegetation or the rates that would degrade groundwater unless specifically authorized (application in excess of nitrogen requirements may be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade the quality of underlying groundwater);
- no surface water runoff resulting from irrigation of the site is permitted within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;
- no application is permitted to frozen or water-saturated ground or during periods of rain heavy enough to cause runoff from the site;
- no application or incorporation into the soil is permitted when wind may reasonably be expected to cause airborne particulates to drift from the site;
- no application is permitted in areas subject to erosion or washout offsite; and

- discharge of biosolids with pollutant concentrations greater than those shown in Table 2-4 is prohibited.

## Discharge Specifications of the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be land applied. Most of these specifications are similar to the requirements of the Part 503 regulations and include the following:

- Biosolids must be treated to meet Part 503 standards for vector reduction and be treated to either the Class A or Class B level of pathogen reduction standards.

- Cumulative lifetime metals loading limits for a given application site shall not exceed those presented in Table 2-5 (including background soil levels and levels in applied biosolids).

- Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed for reclamation sites or biosolids research projects.

- Following incorporation of biosolids into the soil, tilling practices must minimize erosion of the site resulting from wind, stormwater, and irrigation water.

- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.

- For Class B biosolids, the harvesting period for crops is restricted as described in the Part 503 regulations. In addition, the location of application is specified with respect to property lines, municipal and agricultural supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

## Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirement for biosolids to be transported in covered, leakproof vehicles; drivers must carry a copy of an approved spill response plan and be trained with regard to the proper response to accidents or spill events. The GO defines *storage* as placement of biosolids on the ground or in nonmobile containers for more than 7 consecutive days at an intermediate site other than the place of generation and/or processing. If biosolids are to be stored at the application site, the operator must prepare and implement an RWQCB-approved storage program. Biosolids must not be stored for longer than

## Table 2-4.
## Pollutant Concentration Limits for Biosolids Being Land-Applied

| Constituent | Ceiling Concentration (mg/kg dry weight) |
|---|---|
| Arsenic | 75 |
| Cadmium | 85 |
| Chromium | 3,000 |
| Copper | 2,500 |
| Lead | 350 |
| Mercury | 57 |
| Molybdenum | 75 |
| Nickel | 420 |
| Selenium | 100 |
| Zinc | 7,500 |

## Table 2-5.
## Cumulative Loading Limits for Biosolid Land Application Sites

| Constituent | Kilograms per Hectare | Pounds per Acre |
|---|---|---|
| Arsenic | 41 | 36 |
| Cadmium | 39 | 34 |
| Copper | 1,500 | 1,336 |
| Lead | 300 | 267 |
| Mercury | 17 | 15 |
| Molybdenum | 18 | 16 |
| Nickel | 420 | 374 |
| Selenium | 100 | 89 |
| Zinc | 2,800 | 2,494 |

7 consecutive days; storage areas must be covered between October 1 and April 30 during periods of runoff-producing precipitation; public access to storage areas must be restricted; and control measures should be implemented to prevent leachate into the soil, surface runoff, and washout from floods.

## Provisions

The GO contains 20 general conditions and procedures that must be followed by the discharger. The general provisions are summarized under the following categories of responsibilities:

- **Obtaining, maintaining, and terminating coverage under the GO:** An NOI must be submitted for each biosolids source and discharge site. Specific agencies, adjacent residents, and adjacent landowners identified in the GO and any local agency with jurisdiction over the application site must be notified. The RWQCB must be notified in advance of any transfer of the project to another party. The RWQCB must be notified of project completion through submittal of a Notice of Termination and a Final Discharge and Monitoring Program report. Provisions of the general WDRs issued by the RWQCB are severable.

- **Chain of responsibility:** Individual property owners and companies responsible for biosolids discharges and site operations are primarily accountable for compliance and enforcement actions under the GO. The discharger is responsible for informing all biosolids haulers using the land application site of the conditions contained in the GO. Individual property owners are responsible for applicable crop selection, property access, and harvesting restrictions under the GO.

- **Monitoring, reporting, and record keeping:** The preapplication form that is attached to the GO describes the general reporting requirements and specific groundwater monitoring requirements (if deemed necessary). Groundwater monitoring would generally be required if the depth to groundwater at the application site is less than 25 feet and biosolids would be applied to the site more than twice in a 5-year period. If required, one upgradient and two downgradient wells must be monitored annually at each application site to evaluate water level, pH, total dissolved solids, sodium, chloride, nitrate, and total nitrogen levels.

  The discharger is responsible for implementing the requirements of the GO and for site operations and conducting the required monitoring programs. Sampling must be conducted using approved methods, accurate and properly calibrated equipment, and laboratories certified by the California State Department of Health Services. Information that must be recorded includes the quantity of biosolids applied at each site along with its nitrogen content, crops grown, and total pollutant loading. The discharger must notify the RWQCB of any noncompliance with the GO within 24

hours. The discharger must keep monitoring records for at least 3 years. Annual monitoring reports submitted to the RWQCB must be signed and certified by the discharger or a duly authorized representative.

## GO Exclusion Areas

The proposed GO specifies several areas of the state within which biosolids application projects under the GO cannot be permitted. Generally, the exclusion areas are unique or valuable public resources, jurisdictional waters or preserves, or state-designated management areas. The general areas excluded from this GO are the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta;
- Suisun Marsh;
- the area under the jurisdiction of the San Francisco Bay Conservation and Development Commission; and
- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,500 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and areas of the Mono-Owens Planning Area.

These areas are not included in the analysis of this EIR.

# Chapter 3. Soils, Hydrology, and Water Quality

# Chapter 3. Soils, Hydrology, and Water Quality

This section briefly describes the soil properties, hydrologic characteristics, and existing water quality conditions of California watersheds in each of the nine RWQCB regions. Appendix D provides a more comprehensive discussion of the factors that can affect fate and transport mechanisms of biosolids in the soil and aquatic environment. The fate and transport characteristics of pathogens and radioactive substances related to biosolids application are described in Chapter 5, "Public Health".

## Environmental Setting

### Soils

#### Soil Properties Relevant to Biosolids Application

The soil properties described below affect the suitability of a site to be used for biosolids application. Some of these properties may change as a result of biosolids application. Additionally, most of the properties are closely related to a site's productivity with regard to food and fiber crops and livestock forage.

**Texture.** Probably the most influential soil property relative to land application of biosolids is texture (i.e., the proportions of sand-, silt-, and clay-sized particles in the soil). With other factors held constant, most fine-textured soils (e.g., silty clays and clays) have relatively high capacity to retain nutrients and metals, have moderate available water-holding capacity (i.e., the amount of water that can be taken up by plant roots, measured as inches of water per inch of soil or as the water available throughout the root zone), have slow infiltration capacity and permeability (to gas and water movement), and are relatively difficult to till. The pH (discussed below) of fine-textured soils ranges from near neutral to alkaline. Most clayey soils are fairly resistant to erosion when the vegetation cover is removed, except on steep slopes.

Coarse-textured soils (e.g., loamy sands) generally have relatively low nutrient- and water-holding capacities, have low native fertility, have rapid infiltration capacity and permeability, and are easily tillable. Many coarse-textured soils have low organic matter

content. The pH of coarse-textured soils ranges from near neutral to acidic. Fine-sandy soils are among the soils most subject to water erosion.

Medium-textured soils (e.g., loams and silt loams) usually have fertility and hydrologic characteristics intermediate between those of fine- and coarse-textured soils, although they usually have the highest available water-holding capacity. Medium-textured soils, particularly those with high organic matter content, are generally resistant to erosion on gentle to moderate slopes.

**Cation Exchange Capacity.** Cation exchange capacity (CEC) is a measure of a soil's net negative charge and thus of the soil's capacity to retain and release cations (i.e., positively charged ions) for uptake by plant roots. Cations (e.g., calcium and ammonium) are often essential for plant growth in small concentrations, but they may be toxic at higher concentrations (e.g., molybdenum, zinc, and copper). Some trace elements such as lead are not required for plant growth but may be toxic to plants and the animals that feed on them. The CEC of a particular soil is controlled primarily by the amount and type of clay mineral in the soil and the humus (highly decomposed organic matter) and iron oxide contents. In coarse-textured soils, humus may provide most of the soil's CEC. For a given quantity (i.e., weight) of soil, the CEC of humus is typically several times that of most pure clays. Clayey soils commonly have a CEC more than five times that of sandy soils. A high CEC is desirable because it reduces or prevents essential nutrient loss from the soil by leaching (Donahue et al. 1983). Soils with high CEC can also immobilize heavy metals such as copper and lead by binding the negatively charged metal anions to cation exchange sites associated with the clay minerals and organic matter.

**Organic Matter.** Organic matter, another important property of soil, enhances the physical condition of surface soil layers by binding individual soil particles together into larger aggregates (the natural arrangement of soil aggregates provide soil structure). Organic matter particularly benefits the structure of sandy soils. Improved soil structure creates large pores through which gases and water move and which promote root growth. Accordingly, soils with good structure have a lower bulk density and are more permeable than soils with poor structure. A well-aerated, permeable soil is usually more productive than a poorly aerated soil. High permeability improves a soil's infiltration capacity and makes the soil easier to till (Donahue et al. 1983). Furthermore, soils with large, stable aggregates (i.e., well-structured soils) are more resistant to erosion than soils with poor structure (National Academy of Sciences 1996).

Organic matter content also affects the capacity of the soil to retain water and many soluble nutrients and metals, particularly in coarse-textured soils. Organic matter is also the source of most of the nitrogen in an unfertilized soil and can be an appreciable source

of available phosphorus and sulfur. Soil microbes use organic matter as a food source (Donahue et al. 1983).

**pH.** Soil pH is the measure of the acidity or alkalinity (the amount of hydrogen ion) of a soil. Nearly all California soils have a pH in the range of 5.0-8.5; a pH of 7.0 is considered neutral. Soils with a low pH (i.e., less than 5.5) are acidic and may have lower nutrient concentrations and less microbial activity (Tucker et al. 1987). In strongly acidic soils, bacteria that decompose organic matter and therefore release nitrogen and other nutrients for plant growth are less active. In addition, most heavy metals and some nutrients are soluble, and aluminum and manganese may be present at toxic concentrations. Soil pH also greatly affects the solubility of minerals and many heavy metals, and therefore affects their availability for plant growth and uptake in biomass and their potential to be leached from the soil profile. A slightly acidic soil (e.g., pH 6.5) is typically best for many agricultural crops because macronutrients and micronutrients are overall most available for plant uptake under slightly acidic conditions (Donahue et al. 1983). Maintaining neutral to slightly alkaline soils is often recommended in places where high levels of heavy metals are present because the metals tend to be less mobile at these pH conditions.

**Salinity.** Salinity refers to the salt content of a soil. Salts are dissolved mineral substances, including sulfates, chlorides, carbonates, and bicarbonates, which may form from the elements sodium, calcium, magnesium, and potassium. Although a low level of salts in the soil is desirable, high salinity levels (commonly above an electrical conductivity of 4 deciSiemens per meter for many crops) make it more difficult for plant roots to extract water from the soil, which may reduce growth rates. (Donahue et al. 1983.)

**Bulk Density.** Bulk density is a measure of the mass of dry soil per unit volume. It is usually expressed in terms of grams per cubic centimeter. Bulk density affects permeability and root penetration and is affected by texture, structure, organic matter content, and soil management practices. (Donahue et al. 1983.)

**Depth.** Soil depth affects the capacity of a soil to retain nutrients and metals. References to soil depth pertain to the depth of a soil over rock or a restrictive layer that prevents significant root penetration, such as a hardpan or dense claypan. (U.S. Department of Agriculture 1993.)

**Microorganisms.** Soil microorganisms, including bacteria, actinomycetes, fungi, algae, and protozoa, play an important role in the decomposition of organic matter, including that contained in biosolids (Phung et al. 1978), and in the cycling of plant nutrients such as nitrogen, phosphorus, and sulfur (National Academy of Sciences 1996). Some evidence indicates that the rate of decomposition of organic matter by

microorganisms may be reduced in the presence of high concentrations of heavy metals (Sommers et al. 1976).

**Drainage.** A soil's drainage class is determined primarily by its permeability, depth of the seasonal high water table, and slope. At the dry end of the drainage spectrum, soils that are excessively drained tend to be coarse textured, not influenced by high groundwater, and located on steep slopes. Soils that are poorly drained typically have groundwater at or near the surface for much of the crop-growing season and are in level areas and topographic depressions (U.S. Department of Agriculture 1993).

**Water and Wind Erodibility.** Soils that are highly susceptible to detachment and entrainment (i.e., erosion) by water and wind are those made up mostly of coarse silt and fine sand-sized particles (Donahue et al. 1983), particularly in areas where organic matter content is low and the soil structure is poor or nonexistent. Erodibility is usually a characteristic of concern when the vegetative cover is removed or reduced or the soil is otherwise disturbed. Water erosion typically is not a major concern on gentle slopes (e.g., 10% or less, as generally used for biosolids application) because little rainfall runoff results at such slopes. Erosion is usually controlled by maintaining vegetative cover.

The erosion rate of a particular soil in the absence of human activities is referred to as the natural or geologic erosion rate. Erosion in excess of the natural erosion rate is called accelerated erosion and is usually a result of human-caused activities such as cultivation, grazing, and grading.

## Generalized Descriptions of Soil Properties

Soils in California are extremely variable and reflect the diverse geologic, topographic, climatic, and vegetative conditions that influence soil formation and composition. Broad generalizations can be made of soil properties in each RWQCB region which may influence or be influenced by biosolids application, and these are tabulated in Appendix D (Table D-1). Major Land Resource Areas (MLRAs), as classified by the U.S. Natural Resources Conservation Service (NRCS), are large areas that are broadly similar with respect to soils, geology, climate, water resources, and land use. Sixteen MLRAs have been designated in California. MLRA information is appropriate for statewide resource description and planning. Because biosolids are nearly always applied on moderate to shallow slopes (i.e., a maximum of approximately 15%), only soils occurring in valleys, basins, terraces, and alluvial fans are described in Appendix D. Soils occurring in large geographic areas that have been excluded from the GO (i.e., the Sacramento-San Joaquin River Delta, Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

**Typical Soil Properties in Forested Areas.** Soil properties in forested areas of the state that are suitable for biosolids application (i.e., have slopes no greater than approximately 15%) differ from soils typically used for agricultural land application in that they are generally shallow and underlain by bedrock. Forest soils in California tend to have neutral to acidic pH. The organic matter content ranges from relatively low to high (for mineral soils) but is usually concentrated in the upper soil layers. A layer of plant litter often rests on the soil surface. Forest soils are often more thoroughly leached of nutrients than agricultural soils. The texture typically ranges from clay loam to sandy loam, and the soils often have rock fragments in the profile. Except in meadows (which typically would be excluded from biosolids application because they may qualify as jurisdictional wetlands) and seep areas, groundwater tends to be deep. (Colwell 1979, U.S. Soil Conservation Service 1981.)

**Typical Soil Properties at Mined Sites.** Conditions at mined sites differ from those at agricultural land application sites in that the native soil material has typically been partially or entirely removed or mixed with less productive subsoil material. Although soil and site conditions may vary widely according to the type of mine, the soil materials at such sites often have low nutrient- and water-holding capacities, a large amount of rock fragments, low organic matter content, low pH, and high concentrations of trace metals. These conditions result in unfavorable conditions for seed germination and plant growth, making revegetation efforts difficult (Reed and Crites 1984). Slopes may be steep at some mined sites.

**Typical Soil Requirements of Horticultural Operations.** In California, biosolids are not used extensively for horticultural plantings. It is expected that the most frequent uses would be in large parkland or golf course settings, or at large-scale nursery operations. These settings could occur throughout the state, but would likely be focused in valley or low foothill areas with relatively deep soils, moderate to shallow slopes (less than 15%), and a wide range of soil textures (loams to clays). Because horticultural areas are usually selected for their ability to support some type of planted vegetation, they would be expected to have low to medium organic matter content, be well drained, and have a pH from slightly alkaline to slightly acidic. Soil conditions that would be unfavorable for seed germination and plant growth would be avoided. Where new parks or golf courses are being developed, biosolids may be applied to soil material imported from offsite. These soils may have little or no remaining soil structure.

## Hydrology

## Surface Water

The surface waters of California can be divided into six regions of similar hydrologic character, established by the California Department of Water Resources (1994a), that exhibit distinct precipitation, runoff, and geologic conditions. Vast differences in climate, vegetation, and geography between these regions lead to extremes in seasonal patterns, precipitation, and runoff potential throughout the state. The North Coast region, for example, can receive up to 200 inches of rainfall per year, whereas the Colorado Desert region in the southern part of the state receives the least annual rainfall, with some areas averaging less than 2 inches per year (Mount 1995). These patterns, combined with other regional factors, determine the amount and type of runoff emanating from the area, the rate of deep percolation and aquifer recharge, and the potential for flooding. Table 3-1 shows the seasonal patterns, precipitation, and runoff characteristics of the six regions.

## Groundwater

Approximately 40% of the total land area of the state is underlain by groundwater basins. The storage capacity of these basins is estimated to be approximately 1.3 billion acre-feet of water, and many of the basins are estimated to be full or nearly full. The fraction of water that is usable from these basins, about 143 million acre-feet, is more than three times the total capacity of the state's surface storage reservoirs.

Many of California's groundwater basins are located in arid valleys and are recharged by percolation of rainfall and surface water flows. Recharge occurs more readily in areas of coarse sediments, which are usually located near the alluvial fans associated with mountain ranges. Percolation in southern California occurs only during periods of intense precipitation, whereas northern California groundwater basins often receive direct recharge from precipitation on an annual basis (California Department of Water Resources 1975). The location and extent of impermeable, confining layers in the alluvial deposits that contain groundwater basins play a major role in the amount and rate of recharge of percolating water and the overall quality of the groundwater.

About 250 important groundwater basins are present throughout California, supplying about 40% of the state's applied water needs. Statewide, more than 15 million acre-feet of groundwater are extracted for agricultural, municipal, and industrial uses. Table 3-2 lists California's major groundwater basins by region.

# Table 3-1.
# Watershed Characteristics of California

| Region | Seasonal Patterns | Runoff Characteristics | Precipitation |
|---|---|---|---|
| North Coast (Region 1) | Inland - distinct rainy, cool winters and hot, dry summers. Coastal - cool and wet year round with little temperature variation. | Highest peak discharges recorded in state, with highest total sediment yields. | Dominated by rainfall. Average annual precipitation in region is 53 inches. |
| Sacramento, San Joaquin and Tulare Lake (Region 5) | Valley: Hot, dry summers and cool, wet winters. Mountains: Mild summers with intermittent thundershowers, heavy winter snowfalls above 5000 feet. | Prolonged spring runoff fed by Sierra Nevada snowpack. Low sediment yields due to widespread vegetation and stable rock types/soils. Locally high sediment yields due to land uses (e.g., logging, grazing, and urbanization). | Valleys receive winter rainfall, and mountains receive moderate to heavy snowfall. Total average annual precipitation ranges from 36 inches in the Sacramento River region to 13-14 inches for the San Joaquin and Tulare Lake regions. |
| San Francisco Bay and Central Coast (Regions 2 and 3) | Coast: Cool and foggy year-round with rain in the winter. Small seasonal temperature variations. Inland areas: Warmer, dry summers with cooler, rainy winters. | High peak runoffs due small, steep watersheds. Local rivers susceptible to severe flooding during high rainfall events. Some watersheds produce high sediment yields due to unstable rock types/soils. | Precipitation from rainfall, with insignificant snowfall. Northern area average annual precipitation is 31 inches, with greater than 50 inches in some areas. Southern area average annual precipitation is 20 inches. |
| North and South Lahontan (Region 6) | Valleys: Semi-arid high desert terrain. Hot, dry summers with locally intense thunderstorms. Mild, dry winters. Mountains: Cool to mild summers, cold winters with regionally heavy snowfall. | Valleys: High peak runoffs in ephemeral drainages. Watersheds except Owens River are short and steep ephemeral drainages. Stable rock types/soils result in low, coarse-textured sediment yields. Mountains: Extended spring runoff with locally high sediment yields in Sierra. | Valleys: Low to moderate precipitation totals due to rainshadow effects of Sierra Nevada and Cascade Mountains. Mountains: Regionally heavy winter snowfall and intense summer thunderstorms. Average annual precipitation ranges from 8inches in the south to 32inches in the north. |
| South Coast (Regions 4, 8, and 9) | Mediterranean climate with several dry years interrupted by infrequent high precipitation years. Warm, dry summers and mild, wet winters. Inland summer temperatures can exceed 90 degrees. Intense subtropical storms. | Watersheds are largely ephemeral and fed by rainfall. Rivers susceptible to frequent flooding due to high peak discharge events. Sediment yields are locally high due to intense urbanization, low vegetation cover and unstable soils. Debris flows and mudflows frequent in some smaller drainages. | High rainfall with insignificant snowfall contribution. Locally heavy storms have the highest 24-hour rainfall totals in the state. Average annual precipitation is 18.5 inches. |
| Colorado Desert (Region 7) | Arid desert region with hot, dry summers with locally intense thunderstorms and mild winters. Rainfall is limited to a few storms per year. | Low runoff due to limited rainfall, but locally heavy during infrequent storm events. Overall sediment yields are low, but produce debris flows during storms. | All precipitation fall in the form of rain. Region has the lowest yearly precipitation totals in the state, with some areas receiving less than 2 inches. Average annual regional rainfall is 5.5 inches. |

Sources: Mount (1995), California Department of Water Resources (1994a), Regional Water Quality Control Board Water Quality Control Plans (1991-1995).

## Table 3-2.
## Major Groundwater Basins of California

| Region | Major Groundwater Basins | Extraction (ac-ft/yr) |
|---|---|---|
| 1 - North Coast | Tule Lake, Siskiyou Butte Valley, Shasta Valley, Scott River Valley, Hoopa Valley, Smith River Plain, Mad River Valley, Eureka Plain, Eel River Basin, Covelo Round Valley, Mendocino County | 242,338 |
| 2 - San Francisco Bay | Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, Santa Clara Valley, Livermore Valley, Marin County, San Mateo County | 190,128 |
| 3 - Central Coast | Soquel Aptos, Pajaro Basin, Salinas Basin, S. Santa Clara - Hollister, Carmel Valley-Seaside, Arroyo Grande/Nipomo Mesa, Cuyama Valley, San Antonio, Santa Ynez Valley, South Central Coast, Upper Salinas, San Luis Obispo | 1,075,800 |
| 4 - Los Angeles | Central Basin, West Coast Basin, San Fernando Valley, Raymond Basin, San Gabriel, Upper Ojai Valley, Fox Canyon | 808,000 |
| 5 - Central Valley | Butte County, Colusa County, Tehama County, Glenn County, Sacramento County, Western Placer County, Yuba County, Sutter County, Eastern Solano County, Yolo County, Sierra Valley, Goose Lake Basin, Big Valley, Fall River Valley, Redding Basin, Almanor Lake Basin, Upper Lake Basin, Lake County/Scotts Valley, Kelseyville, Valley Basin, Coyote Valley, Middletown-Colalyomi Valley, San Joaquin County, Modesto Basin, Turlock Basin, Merced Basin, Chowchilla Basin, Madera Basin, Delta Mendota, Kings Basin, Tulare Lake Basin, Kaweah Basin, Tule Basin, Westside Basin, Pleasant Valley Basin, Kern County Basin | 8,302,100 |
| 6 - Lahontan | Surprise Valley, Honey Lake Valley, Long Valley Basin, Thermo-Madeline Plains, Willow Creek Valley, Secret Valley, Owens Valley, Death Valley, Mojave River Valley, Antelope Valley | 397,200 |
| 7 - Colorado River | Warren Valley, Coachella Valley, Cuckwalla | 114,740 |
| 8 - Santa Ana | Orange County (also in Region 9), San Bernardino Basin Area, Riverside Basin Areas 1 and 2, Colton Basin | 498,180 |
| 9 - San Diego | Temecula Valley, San Juan Valley, El Cajon Valley, Sweetwater Valley, Otay Valley, Warner Valley, San Luis Ray | 34,000 (total does not include Warner Valley or San Luis Rey - extraction rates unknown) |

Sources: California Department of Water Resources (1994a), and California Department of Water Resources (1975).

## Water Quality

Monitoring for water quality protection purposes is conducted through a variety of federal, state, and local programs. The state evaluates current water quality conditions and prioritizes funding efforts for protection, cleanup, and monitoring programs through the individual water quality assessments that are compiled into the SWRCB Section 305(b) reporting process, which is mandated under the federal Clean Water Act (California State Water Resources Control Board 1996a). The Section 305(b) report includes the Section 303(d) lists, which identify water bodies that do not meet applicable water quality standards or designated beneficial uses that are subject to technology-based controls for waste discharges.

Water quality issues differ depending on the location and type of water resource; the size and extent of the watershed and water resources; the location with respect to potential pollutant sources; seasonal and climatic factors; and many other interacting physical, chemical, and biological processes. Medium to large surface water bodies typically have a large capacity to assimilate waste loads of pollutants because various physical and chemical processes are effective at diluting pollutants or transforming them to less harmful components. Biological processes are especially important because many chemical constituents can be absorbed by plants or animals and removed from the water or metabolized in biological tissues to less harmful substances. Consequently, water quality impairment at a large scale is generally associated with watersheds that have extensive development and receive pollutants from a variety of point and nonpoint sources. Point-source pollution is a discharge that originates in a single location, such as a wastewater treatment plant, landfill, or industrial site. Nonpoint-source discharges are generated over a larger area and result from nonlocalized activities such as urban stormwater runoff; mining, agricultural and forestry activities, residential septic systems, or accidental spills.

### Surface Water Quality

Surface water quality depends on seasonal hydrologic pattern, mineral composition of the watershed soils, topography, sources of contaminants, and beneficial uses. During summer low-flow conditions, the surface water quality characteristics of most importance to aquatic life are temperature, dissolved oxygen, turbidity, biostimulatory nutrients (e.g., nitrogen and phosphorus) and nuisance algae growth, and toxic constituents (e.g., un-ionized ammonia and residual chlorine). During the higher streamflow conditions common during winter, water quality is influenced more by stormwater runoff and associated pollutants (e.g., sediment, oil and grease from automobiles and paved areas), nutrients from agricultural fields and livestock boarding areas, and organic litter (e.g.,

leaves and grass clippings). The quality of surface water and groundwater used for domestic, agricultural, and industrial supply are characterized by standards such as total dissolved solids content, turbidity, taste and odor, and levels of toxic contaminants.

The most recent Section 305(b) report indicates that most of the state's surface lakes and reservoirs, rivers and streams, freshwater wetlands, and estuaries only partially support all of their designated beneficial uses. Of the water bodies not supporting all of their uses, a small fraction fail to support one or more designated beneficial uses all the time. For example, 10,838 miles of California's rivers and streams only partially support all beneficial uses; however, only 2,142 miles fail to support one or more beneficial uses all the time. For lakes and reservoirs, approximately 569,000 acres partially support beneficial uses, but only 9,670 fail to support one or more uses all the time. For freshwater wetlands, approximately 107,000 acres partially support beneficial uses, but no wetlands fail to support a beneficial use all the time. The Section 305(b) report also identifies the physical or chemical constituents that cause beneficial uses to not be met. In general, lake and reservoir beneficial uses are impaired predominantly by the presence of noxious weeds, trace metals, pesticides, and taste and odor problems. Rivers and streams are affected by a much larger variety of constituents, including sediment, pathogens, pesticides, and trace metals. Freshwater wetlands are affected primarily by trace metals, salinity, and other trace elements.

## Groundwater Quality

Groundwater quality has typically been less of a concern than surface water quality because many of the usable aquifers for domestic consumption have been protected by the overlying soils and geological structures. Impairment of groundwater quality has typically been associated with percolation from landfills, leaking underground storage tanks, and other readily identified sources of pollution. The public attention and regulatory focus of managing and protecting groundwater quality are increasing, however, because nonpoint sources are known to cause widespread impairment of groundwater quality through the introduction of contaminants such as nitrates from septic systems and agricultural fertilizers, large-scale use of pesticides and herbicides, and potential infiltration of hazardous wastes from past land uses. The long-term increase in salt content of groundwater is also a major source of impairment. Increases in salts are primarily a result of subsurface percolation of irrigation water or seawater infiltration. The San Joaquin Valley has large areas of shallow groundwater that have experienced long-term increases in salt concentration as a result of irrigated agriculture. The most recent Section 305(b) report indicates that approximately 20,000 acres of groundwater basins only partially support all beneficial uses; however, only 1,150 acres fail to support one or more beneficial uses all the time. Approximately 24,800 acres of groundwater basins have elevated levels of toxic constituents.

**Nitrates in Groundwater and Nitrate-Sensitive Areas.** Nitrate contamination of groundwater has been documented throughout California (California State Water Resources Control Board 1988, California Department of Food and Agriculture 1989). Nitrogen is present in groundwater primarily in the nitrate form, although minor amounts of ammonium or nitrite may be present. The California drinking water standard or maximum contaminant level (MCL) is 45 milligrams per liter (mg/l) of nitrate ($NO_3$). This is approximately the equivalent of the state and federal drinking water standard, 10 mg/l of nitrate expressed as nitrogen (N).

Potential sources of nitrate contamination include human and animal waste and large-scale use of nitrogen-based fertilizers. Potential groundwater contamination from nitrates is related to soil characteristics, crop type, irrigation practices, timing and application of nitrogen, geology, climate, and hydrologic conditions. It is difficult to determine whether an observed level of nitrates in groundwater is a result of current or past operations. It is also difficult to quantify the level of nitrate contribution from each potential source (e.g., agricultural, animal waste, septic, or wastewater sources). The most recent statewide assessment of nitrate conditions in groundwater by geographic area in California was produced in 1988 (California State Water Resources Control Board 1988). In general, the data and research available suggest that the potential for subsurface transfer to groundwater of surface-applied nitrogen is highest in highly permeable, sandy soils with low organic matter content under heavy irrigation, and that shallow wells are extremely susceptible. Areas that do not receive a large amount of freshwater recharge also may act as "sinks" and be more susceptible to cumulative loading of nitrates.

The California Department of Food and Agriculture (DFA) has developed criteria for evaluating nitrate-sensitive areas to prioritize funding and research on nitrates (California Department of Food and Agriculture 1998). Soil scientists with the University of California and DFA's Fertilizer Research and Education Program (FREP) identified seven criteria with which to determine the nitrate sensitivity of an area:

- **Groundwater use**—Nitrate concentration is critically important if groundwater is used for domestic or animal drinking supplies.

- **Soil properties**—Sandy or otherwise coarse-textured soils transmit water containing dissolved nitrates downward more rapidly. Also, these soils are less likely to provide the conditions under which nitrate turns to a gas and escapes from the soil (denitrification).

- **Irrigation practices**—Inefficient irrigation systems that lead to large volumes of subsurface drainage increase the leaching of nitrates. Typically, these are surface-flow systems with long irrigation runs. Well-managed sprinkler or drip

systems, or surface-flow systems with short runs, reduce the risk of nitrates leaching to groundwater.

- **Type of crop**—Crop types most likely to increase nitrate leaching are those that (1) need heavy nitrogen fertilization and frequent irrigation; (2) have high economic value, so that the cost of fertilizer is relatively small compared to revenue produced; (3) are not harmed by excess nitrogen; and (4) take up only a small fraction of the nitrogen applied. Many vegetable, fruit, nut, and nursery crops fit these criteria, and therefore have high potential for nitrate leaching. Crops with lower potential include field crops such as alfalfa, wheat, and sugar beets.

- **Climate**—High total rainfall, concentrated heavy rains, and mild temperatures lead to extensive leaching of nitrates.

- **Distance from the root zone to groundwater**—Small distance from the root zone to groundwater indicates that leaching, if it occurs, will be a more immediate problem.

- **Potential impact**—Such factors as population density and availability of an alternate water supply indicate that nitrate leaching is a potential impact in an area.

The focus of FREP field activities has been established on the basis of these criteria. In general, two regions of the state, the Central Coast valleys and parts of the east side of the Central Valley, fit the above criteria.

## Mobility, Bioavailability, and Potential Toxicity of Plant Nutrients and Trace Elements in Biosolids

Several closely related issues are associated with the occurrence of nutrients, trace metals, and synthetic organic compounds in biosolids. The evaluation of what happens to these compounds in the soil, how their presence may affect agricultural productivity and sustainability, how they change and move through soil (to be taken up by plants and grazing animals and ultimately enter the human food chain), and how they are removed from the immediate land application site as soil dust, as eroded particles, or with surface runoff and groundwater flow, is termed a fate and transport analysis.

Most elements present in soil and taken up by plants (including nutrients and toxic metals) must be dissolved in soil water (called the solution phase) to be recovered by plant roots and incorporated into the root mass or aboveground plant biomass. Once absorbed,

elements may be preferentially concentrated in certain parts of the plant (e.g., leaf, petiole, flower, seed, fruit). Where preferential concentrations greatly exceed background soil levels, the compounds are said to bioaccumulate. Elements contained in biosolids are released into the solution phase by microbial decomposition of organic matter containing the elements and by various physical and chemical processes. For this discussion, elements (aside from pathogens, which are discussed in Chapter 5, "Public Health") that are contained in biosolids and released following application during the subsequent decomposition can be placed into three broad groups:

- **Major elements and plant nutrients** (including nitrogen, phosphorus, and potassium)—These and other elements, such as calcium and magnesium, are generally fairly soluble, occur naturally in soils in relatively large amounts, and are required for plant growth in moderate to large amounts.

- **Trace elements and heavy metals**—These occur in biosolids primarily in small quantities and, when released, often form sparingly soluble reaction products. Some trace elements are required for plant growth, whereas other heavy metals may be toxic to plants.

- **Potentially harmful synthetic organic compounds**—These typically are present in biosolids in small amounts and are generally not taken up by plants. The principal concerns with these compounds are ingestion of plants coated with dust from biosolids sources that are unusually high in synthetic organic compounds and direct biosolid ingestion by grazing animals.

## Surface Water Runoff and Groundwater Leaching

Two of the fate and transport pathways evaluated in the Part 503 risk assessment process for land application of biosolids were surface water runoff (pathway 12) and leaching of pollutants to groundwater (pathway 14). Surface water runoff from application sites can occur when rainfall exceeds the infiltration capacity of the soil. Infiltration is influenced primarily by the texture of the soil and the amount of water already stored in the soil. Runoff from application sites may cause accelerated soil erosion and transport of either dissolved or suspended contaminants into surface water bodies.

Leachate is water from either natural precipitation or irrigation that is transported through the soil. Some potential contaminants are soluble in water and may be transported in dissolved forms through the soils. Dissolved contaminants may then move through the soil and percolate to groundwater. Complex biological, chemical, and physical processes govern how water moves through saturated and unsaturated, porous materials.

## Major Elements and Plant Nutrients in Soil

Major plant nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium are typically present in moderate amounts in biosolids; however, their total content, mobility in the soil, and bioavailability can vary widely. In addition, biosolids can contain low to moderate levels of soluble salts.

Nitrogen may be present as organic nitrogen, ammonium, nitrate, and nitrite ions. The transformation processes within the nitrogen cycle are biologically and chemically controlled and include volatilization and biological fixation, mineralization, nitrification, and denitrification. With respect to nitrogen content, biosolids are approximately comparable to barnyard manure, and thus provide a source of low-grade, slow- to moderate-release nitrogen. Biosolids contain 1%-6% total nitrogen as measured by dry weight (National Academy of Sciences 1996). Commercial fertilizers contain 11%-82% total nitrogen. Phosphorus is present in both organic and inorganic forms in biosolids, typically at 0.8%-6.1%. Inorganic forms of phosphorus are relatively insoluble, and phosphorus tends to concentrate in the organic and inorganic solid phases.

Organic forms of nitrogen generally predominate in biosolids and must be converted to inorganic forms by the microbial process of mineralization before they can be used by plants. Nitrogen mineralization rates vary as a function of the organic nitrogen content of the biosolids, soil, and climatic conditions; complete mineralization can take 1-5 years, depending on application rates and site conditions. A smaller percentage of total nitrogen is in the form of gaseous ammonia or dissolved ammonium. Immobilization is the conversion of mineral forms of nitrogen to organic forms. Nitrogen can be stored in soil through binding to cation exchange sites, immobilization by soil microorganisms, or absorption and accumulation in biomass. The ability to store nitrogen as ammonium on cation exchange sites is dependent on the CEC level and soil pH. Dissolved ammonium is converted to nitrite and then to nitrate. Nitrate is highly soluble, biologically available, and chemically stable and is either absorbed into biomass, lost to leaching, or converted to nitrogen gas under anoxic conditions.

In addition to the amount of available nitrogen, another important factor in soil management is the relative quantities of nitrogen and various other nutrients (e.g., nitrogen and phosphorus, nitrogen and carbon). Phosphorus is typically present in biosolids in low to moderate amounts, and organic forms must be mineralized to biologically available forms. The relative proportions of nitrogen and phosphorus are as important in plant nutrition management as the total amounts. If nitrogen in the soil is a limiting factor in plant growth relative to phosphorus, then the relative excess of phosphorus may accumulate in the soil and be subject to erosion and leaching, which could affect surface water and groundwater. This usually is not a significant concern in

most native California agricultural soils, which are generally deficient in both phosphorus and nitrogen. In most California soils, phosphorus is tied up in various chemical forms and is only lost from the soil when it is attached to soil particles entrained by runoff. Phosphorus deficiency in plants can reduce plant growth or affect quality and yield. Similarly, biosolids that are high in carbon but relatively low in nitrogen can induce nitrogen deficiency because soil microorganisms have insufficient soil nitrogen available to fuel their decomposition of the organic matter in the biosolids. Nitrogen deficiency is a rare phenomenon in California. If recognized early, these situations can be remedied by application of commercial fertilizers to bring the carbon:nitrogen or nitrogen:phosphorus ratio into balance with crop needs.

**Transport Mechanisms of Plant Nutrients to Surface Water and Groundwater.** Biosolids application rates are typically dictated by the nitrogen content of the biosolids relative to crop needs, which raises the concern that overapplication may result in the excess nitrogen leaching to groundwater and possibly degrading water quality. Nitrates are difficult to remove from potential sources of drinking water, and both water and fertility must be managed carefully to prevent leaching of nitrates. The total amount of nitrate leaching depends on the amount of nitrate dissolved in the soil-water profile, the volume of water percolating per unit time, and the rate of nitrogen uptake by plants. Once out of the root zone, further movement is governed by complex flow and transport mechanisms, and nitrates may take many years to reach saturated groundwater aquifers (University of California 1995). The nitrate concentration in groundwater is influenced by freshwater recharge and dispersion, both of which may help to reduce contaminant concentrations. Nitrates in groundwater do not impair agricultural beneficial uses of water but may impair the water's usefulness for municipal and domestic purposes.

Runoff of biostimulatory nutrients (nitrogen and phosphorus) may result in eutrophication in receiving waters. Eutrophication is the process by which nutrients increase biological productivity and cause nuisance conditions such as algae scum formation, attached filamentous algae growth on rocks, and excessive growth of vascular emergent and submerged aquatic plants. Increased algae and plant growth can alter the biological system by altering dissolved oxygen and pH conditions in the water or reducing fish habitat. Biosolids application techniques (surface application or incorporation into the soil, with or without tilling), total application rates, seasonal weather patterns, ambient soil moisture, and the duration and intensity of rainfall all influence the potential for runoff to mobilize nutrients in biosolids (Northwest Biosolids Management Association 1998). Liquid biosolids have much greater concentrations of the mobile mineral forms of nitrogen and phosphorus than do the dewatered biosolids. Studies of application of liquid biosolids to a watershed have found little or no impact on stream water quality with respect to nitrogen and phosphorus levels. The application of dewatered biosolids would probably

have no significant impact on the quality of water emanating from watersheds in which dewatered biosolids are applied.

## Trace Elements and Heavy Metals

**Trace Elements and Heavy Metals in Soil.** Trace metals and trace elements are chemical elements that are normally present in the environment in very low concentrations. In small quantities, many elements are essential to plant growth, including fluoride, silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, silicon, selenium, molybdenum, tin, and boron. At higher concentrations, some of these elements may become toxic to plants or accumulate in plants at levels that are toxic to the animals that feed on them (McBride 1984, Dragun 1988, Davies 1980, Kabata-Pendias 1984). In some cases, the range in concentration between deficiency and toxicity is narrow, as is the case with boron. In several cases, there is no known biological necessity for the trace metal, and its occurrence in small quantities in the soil solution may be harmful to plants. Lead, cadmium, and arsenic are examples of this effect. In other instances, such as with molybdenum, there is little or no plant toxicity at elevated soil levels, but grazing animals can be adversely affected if the element is present at high levels in plant forage. Plants can vary widely in their sensitivity to trace element concentrations in the deficiency or toxicity range, their capability to absorb trace elements, and their ability to avoid uptake even at high soil-water concentrations.

Trace metals may behave differently compared to more common soluble salts and plant nutrients in soils. Soil clay content, CEC, organic matter content, oxidation/reduction state, and pH all influence the mobility and bioavailability of metals and nutrients in the soil to varying degrees. The concentrations of major elements and trace metals in the solution phase of the soil-water-plant system are governed by reactions such as acid-base equilibrium, chelation (i.e., a process that binds and stabilizes metallic ions), precipitation and dissolution of solids of oxides and carbonates, and ion exchange-adsorption on clay minerals. Unlike soluble salts, most metallic compounds are not readily soluble in water or very mobile in the soil, except at the low pH levels present in strongly acidic soils. Because of their affinity to soil particles, including clay, organic colloids, carbonates, and iron complexes, trace metals are often retained in the soil and normally do not move readily with the soil-water solution.

Arsenic, molybdenum, and cadmium can be mobile in nonacidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic in low soil-solution concentrations. Boron is also somewhat soluble and mobile, and plants vary widely in their boron phytotoxicity. Boron is naturally present in extremely high concentrations in a small proportion of California soils. The solubility, and hence the mobility and bioavailability, of cadmium, copper, nickel, zinc, and chromium compounds

are significantly pH-dependent. These metals are associated with iron and manganese hydrous oxide compounds, the solubility of which increases with decreasing soil pH and/or more chemically reducing conditions. As a result, the poorly drained, acidic conditions that occur in some California soils favor mobilization of metals whereas well-drained, nonsandy, basic (alkaline) to slightly acidic soils immobilize most cationic metals. Lead generally has limited mobility in the soil. In slightly acidic, noncalcareous (i.e., low calcium content) soils, lead generally is not bioavailable; instead, it precipitates out as lead hydroxides or lead polymorphites and, consequently, does not readily reach groundwater. Thus, the process of maintaining suitable soil pH levels, drainage, and organic matter content is extremely important in managing lands to which biosolids have been applied. Phytotoxic effects of trace elements to crops and other plants are also addressed in Chapter 4, "Land Productivity".

The valley bottomland, basin, and low terrace soils in many areas of California, which are rich in organic matter and clay, should rapidly and effectively immobilize metals contained in biosolids through chelation and cation exchange. Of greater concern are soils that are sandy and acidic and have low organic matter; in these soils, metals are easily transformed to be readily bioavailable and water moves freely with little soil interaction. These soil conditions are somewhat rare in California but occur on recently formed sandy, alluvial fan soils associated with the granitic foothills of the southern San Joaquin Valley, in some high mountain valleys, and in parts of San Diego and Monterey Counties. The soils of valley margin foothills, which often are acidic and have low organic matter content, may also be difficult to manage for effective biosolids application. Areas of shallow perched groundwater may also raise management concerns.

In measuring total metals concentrations in soils and biosolids and total loading rates, no distinction is made between plant-available and mobile forms of metals in the soil-water solution. Except in biosolids from cities with large amounts of heavy industry, most biosolids contain low concentrations of trace metals relative to levels that can accumulate and adversely affect soil productivity and agricultural sustainability under normal California soil conditions and loading rates. The low mobility of biosolids-derived metals in typical soil environments has been demonstrated in research conducted by Camobreco et al. (1996) and Dowdy et al. (1991). However, some scientists recommend caution in assessing the potential for adverse soil quality and health effects of poorly designed and poorly managed programs of biosolids land application and of such programs operating where unusual soil conditions and cropping patterns occur (Cornell Waste Management Institute 1999). Annual application rates and the total amount of biosolids that can be applied over the long term may be dictated by the trace element content of the biosolids to be used.

**Trace Metals in the Aquatic Environment.** The risk assessment procedures used to develop the Part 503 regulations are important factors for the

environmental evaluation of the proposed GO regulation. The following trace metals are identified as priority pollutants by the EPA under federal statutes: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Molybdenum is another trace metal that is of general concern in the regulation of biosolids disposal practices because of its potential for uptake in grazing livestock. The priority pollutant trace metals and molybdenum are known to cause toxicity or otherwise have potential to degrade water resources if present under certain environmental conditions and in sufficient concentrations.

As the metals are transported to lower soil layers, small fractions of metals are partitioned between the soil and water. Several studies have shown that only small fractions of metals move to lower soil layers (Camobreco et al. 1996, Dowdy et al. 1991, Sidle and Kardos 1977, McGrath and Lane 1989). One significant factor that may increase the leachability of metals is the decrease in pH caused by mineralization of biosolids organic matter over time. No conclusive evidence has been found, however, to indicate that decreased pH will increase trace metal leachability. Other studies imply that low pH may be a precursor of high metal mobility leading to groundwater contamination (Wallace and Wallace 1994, Emmerlich et al. 1982, McGrath and Lane 1989).

**Part 503 Risk Assessments of Trace Metals for Surface Water and Groundwater Pathways.** The Part 503 regulations represent the most current understanding of the risks associated with land application of biosolids and are the basis for the proposed GO. Approximately 200 pollutants were originally evaluated for possible consideration in the Part 503 regulations; the risk assessments for surface water and groundwater pathways were ultimately conducted for seven trace metals (U.S. Environmental Protection Agency 1992). All other trace metals either were not detected in the sewage sludges tested during the 1990 National Sewage Sludge Survey (U.S. Environmental Protection Agency 1990) or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations (surface water was designated pathway 12 and groundwater was designated pathway 14), neither the surface water nor the groundwater pathway was found to be limiting to trace metal concentrations or cumulative loading rates resulting from land application of biosolids. Some of the factors evaluated and assumptions used during the Part 503 development process to set limits on trace metals are controversial among researchers and respondents to the scoping notice for this EIR.

In the 1998 CASA survey of trace metal concentrations in sewage sludges from California (California Association of Sanitation Agencies 1999), average concentrations and variability were below the levels reported from the 1990 National Sewage Sludge Survey (NSSS) (U.S. Environmental Protection Agency 1990). Average concentrations of cadmium, copper, lead, nickel, and zinc in the 1998 CASA data range from 25% to 50% of the 1990 national averages; 1998 CASA averages for arsenic, mercury, and

molybdenum are generally similar to the respective national estimates. Selenium is the only trace metal that has higher average concentrations in the 1998 CASA data than in the 1990 NSSS results. Maximum reported concentrations of copper, mercury, and selenium are the only trace metals in the 1998 CASA survey data that exceed the concentration limits identified under the discharge prohibitions of the proposed GO regulation.

## Synthetic Organic Compounds

**Synthetic Organic Compounds in Soil.** Many SOCs used in industrial, commercial, and household applications can be transported to wastewater treatment plants through the municipal wastewater collection and treatment process and therefore can be present in biosolids. As is the case with nutrients and trace elements, the SOC content of the biosolids is determined by the type of business and industry within the wastewater treatment service area, any onsite pretreatment conditions, and the effectiveness of the wastewater treatment process. Many of these organic compounds either are volatile, and so are lost during the treatment process, or biodegrade readily during the treatment process, which is designed and managed to foster microbial decomposition. Other volatile compounds are quickly lost to the atmosphere following biosolids incorporation in the soil. For these reasons, the possible presence of volatile organic compounds in biosolids has generally not been of great concern to regulators and the general public.

Various other nonvolatile organic compounds or semivolatile organic compounds (SVOCs) generally are present in low amounts in municipal biosolids. These include plastic-like compounds (phthalates), pesticides, phenols, detergent additives, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and the group of chlorinated dibenzo-para-dioxin and chlorinated dibenzo-furan compounds that are often cumulatively referred to as dioxins. The Part 503 regulations do not require that biosolids be tested for SOCs; however, the proposed GO monitoring program would require testing of biosolids for PCBs and SVOCs. Upper limits are set by state and federal hazardous materials rules and regulations, with local municipalities enforcing source inspection and pretreatment provisions associated with their wastewater discharge permits. Toxic chemicals such as DDT, chlordane, aldrin, dieldrin, benzo(e)pyrene, and lindane are known to cause cancer, and other compounds (e.g., dioxin; 2,4,5-trichlorphenol; and pentachlorophenol) are known to cause birth defects. Consequently, many SOCs have been prohibited from being used or manufactured in the United States.

Compared to the large amount of detailed information available on trace elements, much less is known about soil accumulation, plant uptake, and concentration mechanisms of SOCs in soils. The knowledge base is much broader for the attenuation, degradation, and

mobility of volatile compounds, pesticides, and PAHs in the soil. The primary exposure pathways for organic compounds are generally understood to be migration to drinking water sources or dispersal as residues and soil dust that accumulate on plant leaves, rather than direct plant uptake. Direct ingestion, either of soil that contains biosolids or of dust on plant parts by grazing animals, is another exposure pathway of concern. Bioaccumulation of these compounds may lead to increased risk factors for human health effects. Potential phytotoxic effects of SOCs to crops and other plants are addressed in Chapter 4, "Land Productivity".

**Synthetic Organic Compounds in the Aquatic Environment.** More than 100 EPA-designated organic compounds are regulated as priority pollutants through federal and state drinking water standards, ambient surface water quality criteria, and hazardous waste laws. Most of these compounds are generally not detected in biosolids or are present at very low levels (U.S. Environmental Protection Agency 1990).

In general, transport of organic compounds from the solid to the liquid phase of the soil environment is limited for most constituents (U.S. Environmental Protection Agency 1992, Chaney 1990). Demirjian et al. (1987) showed that organic compounds originating from biosolids application were degraded in the soil or were adsorbed in the surface layer. At an application rate of 100 tons per acre, most compounds degraded considerably during one irrigation season. At an application rate of less than 25 tons per acre, most compounds degraded to less than 50% of their initial concentration. The authors concluded that the sandy soils in the study area and the heavy irrigation required for the experiment represented severe conditions for land application and that nutrients and trace metals would be the limiting factors in determining appropriate application rates under average soil conditions (Demirjian et al. 1987).

Alexander (1995) showed that the binding effect that causes toxins to persist in the soil becomes more pronounced the longer the pollutant remains in soil and that higher organic matter content leads to a greater binding effect. The report states that the disappearance of appreciable amounts of insecticides from a field was not a result of leaching because all chemicals were extensively adsorbed to soil particles or organic matter and little vertical movement has been detected, even after many years. As a chemical persists in the soil and remains in contact with particulate matter for an extended period, it becomes increasingly resistant to extraction by many solvents. For example, Rappe et al. (1997) reported that dioxins have extremely low solubility and are unlikely to leach from soil into groundwater.

**Part 503 Risk Assessments of Synthetic Organic Compounds for Surface Water and Groundwater Pathways.** SOCs were included in the original pollutant screening and risk assessments conducted during development of the Part 503 regulations for land application of biosolids. Of

approximately 200 pollutants originally evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water (pathway 12) and groundwater (pathway 14) were ultimately conducted for 10 priority pollutant organic compounds (U.S. Environmental Protection Agency 1992). Other organic compounds either were not detected in the tested sewage sludges or were detected at sufficiently low concentrations to warrant no further consideration. The groundwater pathway was not found to be the limiting pathway for concentration limits or cumulative loading rates of any organic compounds resulting from land application of biosolids. The surface water pathway (i.e., humans eating fish that have accumulated pollutants from surface runoff) was the limiting pathway for setting limits on DDT/DDE compounds.

Upon completion of the risk assessments for organic compounds, the EPA concluded that regulations for organic compounds were not required for the final Part 503 regulations because each of the compounds met at least one of the following criteria:

- the pollutant is banned from being used, has restrictions on its use, or is not manufactured in the United States;
- it was detected in less than 5% of the sludges tested for the 1990 National Sewage Sludge Survey; or
- the 1-in-10,000 cancer risk limit was less than the 99% maximum probable concentration based on 1990 NSSS data.

Limits were not set for DDT/DDE compounds because they are excluded from all EPA screening criteria. Several organic compounds were deferred for future consideration and evaluation during the second round of regulation development. The organic compounds of interest for future consideration are PCBs, chlorinated dibenzo-para-dioxins, and chlorinated dibenzo-furans (dioxin). Research is also being conducted on other aromatic surfactants (e.g., linear alkylbenzene sulphonates and ethoxylates) that may have hormone-mimicking properties; however, little is known about their means of transport from biosolids application sites (Krogman et al. 1997, Clapp et al. 1994).

Some of the factors and assumptions used during the Part 503 development process to set limits on toxic organic compounds are controversial. The elimination and deferment of Part 503 limits for organic compounds is a source of some controversy among researchers, as indicated by respondents to the scoping notice for this EIR. The primary arguments presented in favor of setting limits on organic compounds in the Part 503 regulations include the following:

- the elimination process was arbitrary,

- the lack of monitoring requirements means that no information is available on which to base application decisions,
- the risk assessment does not address risks associated with specific compounds for which supporting research data are lacking, and
- groundwater dilution factors identified in the risk assessment may have been too large (Cornell Waste Management Institute 1999).

Comments received during the scoping process indicated a concern that the Part 503 risk assessments may not accurately reflect environmental conditions in California or account for risks from new organic compounds such as pharmaceuticals. General concern was also expressed regarding the assumptions used for the Part 503 regulations regarding synergistic or combined risks from exposure to multiple constituents that may be present in biosolids. EPA contends that the risk assessment process was based on conservative assumptions and that no scientific data have been presented that would invalidate the results of the risk assessments (U.S. Environmental Protection Agency 1995).

# Regulatory Setting

## Key Policies, Laws, and Programs

### Water Quality Regulations and Permits

Numerous policies, laws, and programs are administered by local, state, and federal agencies to enforce limitations on the discharge of pollutants to the environment; maintain surface water and groundwater quality at existing levels; and protect beneficial uses such as municipal, industrial, and agricultural water supply, recreation, and fish and wildlife habitat. Federal, state, and local water quality regulations apply to any chemical constituent contained in biosolids or any activity that would occur as a result of land application of biosolids.

The SWRCB establishes water quality control policies in California in accordance with the State Porter-Cologne Water Quality Control Act and the federal Clean Water Act and implements those policies through nine RWQCB offices. The nine regions were initially established according to similar and unique hydrologic and water quality characteristics. Figure 1-1 shows the names and boundaries of the nine RWQCBs.

Each RWQCB has primary responsibility for designating the beneficial uses of water bodies within its region, establishing water quality objectives for protection of those uses, issuing permits, and conducting enforcement activities. Beneficial uses are defined as those uses of the water resource for which numerical and narrative water quality objectives have been established to prevent water quality impairment. Water quality objectives and associated narrative and numerical water quality objectives are established in a Basin Plan for each region that is updated through a triennial review process. The principal permitting processes administered by the RWQCBs for water quality protection are WDRs imposed on waste discharges to land and water, and permits issued under the NPDES as required by the federal Clean Water Act. WDRs and NPDES permits issued to waste dischargers impose discharge restrictions and pollutant limits that take into consideration applicable state and federal water quality criteria for surface water, groundwater, and drinking water. The permit processes must also consider the state's antidegradation policy, which is intended to protect high-quality waters by setting criteria that must be met before a discharge is allowed that would reduce water quality and yet maintain beneficial uses.

**Numerical Water Quality Criteria.** Numerical water quality criteria that apply to this program include Basin Plan water quality objectives for surface water and groundwater, state and federal ambient surface water quality criteria, and state and federal drinking water standards. The RWQCBs are required to include effluent limitations on toxic priority pollutants in any WDRs and NPDES permits issued for wastewater discharge to surface waters when the discharge may cause the surface water to exceed established standards for priority pollutants. Regulated priority pollutants include approximately 130 trace metals and organic compounds that are known to be toxic to living organisms when present in water at sufficient concentrations.

Regulations pertaining to priority pollutants have been developed in four main regulations: narrative requirements in the Clean Water Act, the National Toxics Rule (NTR), the rescinded Inland Surface Waters Plan/Enclosed Bays and Estuaries Plan (ISWP/EBEP), and the recently proposed California Toxics Rule (CTR). The proposed CTR was developed in accordance with Section 303(c)(2)(B) of the Clean Water Act (Federal Register Vol. 62, No. 150 - August 5, 1997) to fill the gap in regulation created when the ISWP/EBEP was legally challenged and overturned. The SWRCB subsequently issued a Draft Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California and Accompanying Functional Equivalent Document (California State Water Resources Control Board 1996b) that identifies the proposed rules for using the CTR criteria as a new ISWP/EBEP. Following adoption of the CTR or another form of ISWP/EBEP, wastewater discharges and NPDES-permitted facilities will be required to comply with the new standards for priority pollutants.

Drinking water standards, established by DHS under Title 22 CCR Division 4, Chapter 15 - Domestic Water Quality and Monitoring, apply to groundwater and surface water. EPA has developed similar standards under the federal Safe Drinking Water Act. Both sets of laws contain MCLs that are based on a one-in-a-million ($10^{-6}$) incremental risk of cancer from ingestion of carcinogenic compounds and threshold toxicity levels for other compounds. The MCLs are also based on technological and economic factors relating to the feasibility of achieving and monitoring the pollutants in a drinking water supply. Secondary MCLs are established for welfare considerations such as taste, odor control, and laundry staining. The MCLs apply primarily to the quality of water after it has entered a distribution system they apply to source water only when specifically established in a region's Basin Plan by the RWQCB.

**NPDES Permits.** Discharges of waste to surface water bodies, including discharges from wastewater treatment plants (WWTPs), are regulated through the NPDES permitting process, which is mandated under the Clean Water Act. The NPDES permit program regulates ~~for~~ point-source discharges, such as industrial stormwater facilities and WWTPs. The NPDES permit process for WWTPs typically involves the imposition of various chemical, physical, and biological standards on the effluent and receiving water body. Biosolids treatment and disposal regulations can be included in the NPDES permit for the treatment plant or can be covered under separate WDRs.

**National Pretreatment Program for Industrial Discharges.** Pretreatment of industrial discharges is mandated by the Clean Water Act of 1977 (33 U.S. Code [USC] Sections 1251-1376; Public Law [P.L.] No. 95-217, 91 Stat. 1566). EPA has established pretreatment standards (40 CFR Part 403) for various industrial categories. EPA created the National Pretreatment Program and first issued pretreatment regulations in November 1973. Following amendment of the Clean Water Act, the regulations were revised in June 1978 and again in January 1981. The purpose of the National Pretreatment Program is to regulate the discharge of pollutants to municipal ~~sanitary~~sanitation sewers. The goal is to protect receiving water quality and the environment from pollutants that can pass through a WWTP relatively unaffected by the treatment processes. An individual pretreatment program will typically involve several steps:

- identification of pollutants that could cause upset or bypass (pollutants of concern);
- development of discharge limitations for nondomestic discharges (local limits);
- identification of nondomestic discharge sources; and

- implementation of nondomestic monitoring programs to enforce the local limits.

Source control programs have significantly reduced the biosolids pollutant concentrations. This is shown by the decrease in biosolids pollutant concentrations at facilities with aggressive source control programs. As source control programs are continually being improved because of more stringent pollutant limitations, pollutant concentrations in biosolids will continue to decrease or, at a minimum, remain the same.

## Nitrate Management: Research, Technical Support, and Technology Transfer on Agronomic Rates

In 1988, the SWRCB prepared the Nonpoint Source Assessment Report (California State Water Resources Control Board 1988), documenting water quality threats and evaluating programs designed to reduce nonpoint-source pollution. Unlike point sources of contamination that are discreet and subject to regulatory control, nonpoint sources of contamination are typically associated with longstanding and generally acceptable societal practices and land use activities where liability for contamination is hard to determine, and where regulatory programs cannot easily remedy the problem. Agriculture, silviculture, urban stormwater runoff, and grazing are land use activities that have the potential to degrade water quality. The SWRCB has begun to define strategies to deal with nonpoint-source contamination and is developing a watershed management initiative (California State Water Resources Control Board 1995a). The Technical Advisory Committee for Plant and Nutrient Management was convened to assist in developing the Initiatives in Nonpoint Source Management (California State Water Resources Control Board 1995b); these management initiatives respond to nonpoint-source contamination in California. The committee recommended that specific assessments of farming activities be conducted by agricultural experts familiar with unique agronomic conditions and local practices. It was anticipated that these assessments would be used to define appropriate best management practices (BMPs) to control nutrient leaching and make available the best available information and current research.

DFA's FREP program was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. The program facilitates and coordinates the development of applied research and demonstration projects that provide technical assistance and funding to carry out research, demonstration, and education projects related to use of nitrogen fertilizers in agriculture. FREP also seeks to improve access to information on agronomic uses of nitrogen and serves as a clearinghouse for data and research. Funding is provided by a tax on agricultural fertilizers. FREP is part of the Nitrate Management Program established by DFA in 1990 to identify nitrate-sensitive areas and reduce the agricultural industry's share of nonpoint-source nitrate contamination. The information and research generated and distributed by FREP will

assist in defining nitrogen agronomic rates for a range of crops and conditions found in California.

The Certified Crop Adviser (CCA) program has been developed by the American Society of Agronomy (ASA) in cooperation with agribusiness retail dealers, cooperatives and manufacturers, state and national trade associations, the U.S. Department of Agriculture (USDA), and independent consultants. The aim of this group is to develop a voluntary program for crop advisers that would establish standards for knowledge, experience, ethical conduct, and continuing education; enhance professionalism; and promote dialogue among those involved in agriculture and natural resource management.

The University of California, California State University, local County Agricultural Extension Service offices, NRCS, and USDA are all actively pursuing projects and research related to nutrient management and agronomic rates of nitrogen for various crop conditions in California. This information is being made widely available through local resource conservation districts, water districts, agricultural organizations, and county agricultural commissioners. These same groups have been conducting research and demonstration projects to evaluate the effectiveness of on-farm BMPs for reducing nitrate contamination.

## Drinking Water Source Water Assessment and Protection Program

The DHS Division of Drinking Water and Environmental Management is developing a program to assess the vulnerability of drinking water sources to contamination (California Department of Health Services 1999). This program, which is required by federal and state law, is called the Drinking Water Source Water Assessment and Protection (DWSWAP) Program. The wellhead protection portion of the program has been approved by EPA, and DHS anticipates receiving approval of the surface water component in mid-1999. Completion of drinking water source assessments is required by April 2003. The federal Safe Drinking Water Act requires states to develop a program to assess sources of drinking water and establish protection programs.

California's DWSWAP Program is the first step in the development of a complete drinking water source protection program. The DWSWAP Program will include evaluation of both groundwater and surface water sources. The groundwater DWSWAP program includes components intended to fulfill the requirements for state development of a Wellhead Protection Program strategy, as required by Section 1428 of the Safe Drinking Water Act amendments of 1986. A Wellhead Protection Area (WHPA), as defined by the 1986 amendments, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which

contaminants are reasonably likely to move toward and reach such water well or wellfield".

DHS must inventory possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area. An essential element of the DWSWAP program is an inventory of PCAs that are considered to be potential sources of contamination in the designated drinking water source areas and protection zones. Irrigated agriculture and land application of biosolids are recognized as PCAs. As such, specific setback requirements from municipal and domestic wells and from surface water sources that provide drinking water will be required upon completion of the assessments and vulnerability analyses by DHS or locally responsible agencies. Biosolids application and agricultural applications of fertilizer are classified as having a moderate potential risk of contaminating drinking water (California Department of Health Services 1999).

## Groundwater Management Plan (AB 3030)

Sections 10750-10756 of the California Water Code (AB 3030) were signed into law in 1992 and describe components that may be included in a groundwater management plan developed by a local agency to protect groundwater. In all, 149 agencies have adopted groundwater management plans in accordance with AB 3030 (California Department of Water Resources 1994c). Each component would play a role in evaluating or operating a groundwater basin so that groundwater can be managed to maximize the total water supply while protecting groundwater quality. California Department of Water Resources Bulletin 118-80 defines groundwater basin management as including planned use of the basin's yield, storage space, transmission capability, and water in storage (California Department of Water Resources 1975). Ground water basin management includes:

- protection of natural recharge and use of intentional recharge,
- planned variation in amount and location of pumping over time,
- use of groundwater storage conjunctively with surface water from local and imported sources, and
- protection and planned maintenance of groundwater quality.

The 12 components listed in Section 10753.7 of the Groundwater Management Act (AB 3030) form a basic list that includes data collection and operation of facilities that may be undertaken by an agency operating under this act. With respect to protecting

groundwater from potential contamination from biosolids, the critical components to be included in local plans include the following:

- identification and management of wellhead protection areas and recharge areas,
- regulation of the migration of contaminated groundwater,
- administration of a well abandonment and destruction program,
- monitoring of groundwater levels and storage, and
- review of land use plans and coordination with land use planning agencies to assess the risk of groundwater contamination from various activities.

# Impacts and Mitigation Measures

## Approach and Methods

The evaluation of impacts is supported by the information provided in "Environmental Setting", which is referred to when necessary to support the impact determinations. The evaluation included a review of the available research and scientific literature used to support the development of the Part 503 requirements and similar documentation from other biosolids application projects. Potential impacts were evaluated based on available data regarding the extent, duration, frequency, and intensity of possible biosolids-related effects on soils, hydrology, and water quality. Impacts that affect land productivity and land classification are described in Chapter 4, "Land Productivity".

## Thresholds of Significance

Adoption of the GO may have a significant impact on soils, surface water, or groundwater if it would:

- substantially alter existing drainage patterns of the site or area in a manner that would result in substantial erosion or sedimentation, either onsite or offsite;

- substantially alter existing drainage patterns on the site or in the area, resulting in substantial increases in the rate or amount of surface runoff and cause flooding onsite or offsite, or which would contribute runoff water that would exceed the capacity of the existing or planned stormwater drainage system;
- increase the demand for surface water or groundwater supplies in areas with existing shortages;
- violate RWQCB water quality standards or objectives or cause impairment of beneficial uses of water;
- substantially deplete groundwater supplies or interfere with groundwater recharge to such a degree that there would be a net deficit in aquifer volumes or lowering of the local water table.

## Impacts of Agricultural Use

### Impact: Changes to Existing Drainage Patterns or Increase in Surface Runoff

In many areas of the state, land application of biosolids may have beneficial impacts on soils associated with reduction in runoff as a result of increased infiltration capacity and improvement in soil conditions that reduce the potential for erosion. Biosolids application activities that would occur under the GO would cause negligible alteration of existing drainage patterns or increase in erosion or sedimentation, either onsite or offsite. None of the activities that may occur under adoption of the GO would increase the rate or amount of surface runoff, result in flooding onsite or offsite, or contribute to additional runoff of water exceeding the capacity of existing or planned stormwater drainage systems. The improvements in soil water-holding capacity may reduce water demand in silvicultural, horticultural, or agricultural operations. This impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

### Impact: Changes in Groundwater Supply and Hydrology

None of the actions anticipated to occur through application of the GO are anticipated to cause increases in demand for groundwater or to alter the rate or direction of

groundwater flow. Improvement of the soil's water-holding capacity may be a beneficial impact and reduce water demand over pre-application conditions at horticultural, silvicultural, reclamation, and agricultural sites. This impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Impact: Potential Degradation of Surface Water from Nutrients in Biosolids

Land application of biosolids has the potential to degrade the quality of surface water, including adjacent streams, lakes, and wetlands, through surface runoff of pollutants from the application sites. Potential mechanisms of contamination from pollutants include the following:

- During low-probability rainfall events or accidental overirrigation, surface flow rates could exceed soil infiltration capacities and the capacity of runoff control facilities, resulting in runoff entering surface water less than 30 days after application, in violation of provisions of the GO.
- Biosolids being applied to previously uncultivated land could be placed directly into undetected seasonal wetlands (e.g., vernal pools) during the dry season.
- Accidents could occur during transport of biosolids, with resulting discharge to surface water.

In California, environmental conditions that could lead to surface water runoff are primarily present in areas with many surface streams and other water bodies. Areas of high winter rainfall, such as the north and central coastal regions and interior northern California, have the greatest potential for rainfall intensities that could exceed the capacity of runoff control facilities. Seasonal wetlands are present throughout the Central Valley and coastal plains, and in these areas careful consideration would be required in selecting locations for biosolids application projects. Accidents related to transport of biosolids might also result in discharge of biosolids to surface waters, but this event would not be expected with sufficient frequency or probability to warrant specific mitigation measures at the programmatic level of analysis.

The proposed GO contains several prohibitions and specifications that would minimize or prevent the occurrence of pollutant runoff for most site-specific conditions in California. The GO prohibits discharges that could cause pollution and further requires that there shall be no discharge of biosolids from the storage or application areas to adjacent land

areas not regulated by the GO, to surface waters, or to surface water drainage courses. The discharger would not be able to apply biosolids directly to surface waters, and GO specifications are consistent with Basin Plan policies for water quality protection. The NOI requires dischargers to provide site-specific information that each RWQCB would use to evaluate whether surface runoff would be prevented. This information includes the site location and map, location of surface waters, types of crops grown, rate of biosolids application, and identification of periods to be avoided to prevent runoff from the biosolids application site. The SWRCB and individual RWQCBs are responsible for reviewing discharger-provided information, evaluating site-specific conditions, and determining whether the biosolids application project under an individual NOI would comply with the minimum standards of the GO.

For the discharger to be able to comply with the GO, appropriate BMPs that meet industry standards and guidelines would have to be implemented that are effective at preventing accelerated erosion and runoff. The discharge of contaminants to surface waters from biosolids application sites can be prevented by controlling offsite runoff, avoiding wet-weather application of biosolids, and incorporating biosolids into the soil after application. The information needed to design and implement a biosolids application project that is in compliance with provisions of the GO is readily available from existing databases; agricultural extension programs; and through the services of knowledgeable agricultural, horticultural, or forestry professionals. As described above, several state and federal agencies maintain databases that provide hydrologic and climatic information.

Minimum standards under the GO that would ensure protection of surface waters from water quality impairment include setback distances from water bodies, requirements to control runoff through limited seasonal periods for application, use of vegetated buffer strips, and preparation of erosion and sediment control plans for steep slopes. Refer to Chapter 8, “Fish”, for the discussion regarding potential impacts on fisheries productivity resulting from temporary discharges of suspended solids and sediment. Surface and subsurface runoff of toxic substances could also affect fisheries by causing toxicity to protected species in enclosed water bodies. These specific impacts are not considered significant to water quality, however, and this impact is therefore considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Impact: Potential Degradation of Groundwater from Nutrients

The evaluation of potential impacts on groundwater is focused on nitrate because the GO prohibits biosolids application rates that exceed the agronomic rate of nitrogen uptake by plants. Nitrate is highly soluble in water and chemically stable in the aquatic environment,

and the requirements for applying biosolids at the agronomic rate were established to reduce the available pool of nitrate, which may then be leached and transported to groundwater. The GO defines the agronomic rate as "the nitrogen requirements of the plant needed for optimal growth and production, as cited in professional publications for California, the County Agricultural Commissioner, or recommended by a Certified Agronomist". This is a conservative standard and is acknowledged to be the limiting factor for determining the total allowable dry-weight application rate of biosolids under typical environmental conditions. The GO prohibitions also state that "the discharge shall not cause or threaten to cause pollution", which implies that nitrate levels in groundwater must not cause violations of the Safe Drinking Water Act such as exceedance of the 45-mg/l-as-$NO_3^-$ standard at a well providing municipal or domestic drinking water. The potential rate of leaching of other pollutants to groundwater, such as trace metals and SOCs, would be less than the leaching rate for nitrate because those compounds are less soluble and are typically present in lower concentrations relative to their solubility characteristics.

Biosolids applications could provide a net benefit if the nitrogen contribution is factored into the overall on-farm soil, water, and fertility management program. Biosolids have the potential to reduce the reliance on chemical fertilizers. A large fraction of the nitrogen contained in biosolids is bound in an organic form, such that the required mineralization process reduces the rate and quantity of soluble nitrate formation that is then available to leach beyond the root zone. Increased water-holding capacity of the soil ~~by~~resulting from biosolids application could reduce nitrate leaching. Increases in soil organic matter as a result of biosolids application could improve nutrient cycling and overall soil productivity, and the improved management techniques that may result from consultation with certified crop consultants could reduce cumulative nitrate loading from historic levels.

Even at agronomic rates, however, some leaching of nitrates may occur at biosolids application sites. The potential for leaching of nitrates is closely related to the amount of water that is available to transport dissolved contaminants from the root zone. When water moves out of the root zone, whether as a result of irrigation or as runoff from rainfall during winter fallowing of agricultural land, some nitrate will move out of the biologically active soil zone as a dissolved constituent in the leachate. This could affect groundwater if land application resulted in any of the following conditions:

- nitrogen concentrations in biosolids leachate that exceed drinking water standards as a result of:
  - unknown agronomic rate or inaccurate rate calculation (i.e., failure to account for cropping pattern and rotation, timing of biosolids application, total volume of nitrogen applied, rate of mineralization);

- irrigation not being closely managed and water being applied in excess of the soil's water-holding capacity at times when nitrates are available for leaching from the soil;

- rainfall exceeding the soil's water-holding capacity over the winter or during fallow periods, resulting in nitrates leaching from the soils;

- nitrogen concentrations in biosolids leachate that exceed drinking water standards and site-specific evaluations that do not consider local hydrogeology, groundwater assimilative capacity, or vulnerability of municipal and domestic wells; or

- nitrogen concentrations in biosolids leachate that exceed drinking water standards and existing groundwater quality that is close to exceeding the drinking water standard, groundwater quality that is unknown and close to exceeding the standard, or a groundwater basin that is internally drained such that there is limited assimilative capacity.

There are several areas in California where the susceptibility to nitrate contamination is particularly severe. Nitrate-impaired basins have been identified by the SWRCB (California State Water Resources Control Board 1988). In areas with high evapotranspiration rates and high dissolved salt concentration of irrigation water, irrigation water is intentionally overapplied to maintain soil productivity. In California, the major areas where irrigation is used for leaching of salts are the Imperial and Coachella Valleys, the southern San Joaquin Valley, Tulare Basin, and other regions of the Central Valley. Winter precipitation on fallow land may also mobilize nitrates in many areas of the state, primarily the coastal communities that receive heavy rainfall, interior areas of northern California that receive heavy rainfall, and forested areas that have large amounts of snow.

Even if nitrate levels in biosolids leachate may exceed the established drinking water standards, the impact of leachate on groundwater would not necessarily be significant if water quality standards in the groundwater are not exceeded and beneficial uses are not impaired. Some nitrate leaching is acceptable if the groundwater assimilative capacity is sufficient to prevent degradation of groundwater quality or if the nitrate concentration in the leachate is less than that in the groundwater. In some areas of the state, the groundwater may not support the beneficial use as domestic supply, in which case the RWQCB is allowed to make site-specific decisions regarding the level of pollution control that is required for a project.

For typical soil and hydrologic conditions present in California, land application of biosolids at agronomic rates of nitrogen uptake has a low probability of impairing groundwater because the GO prohibits biosolids application projects that would cause such degradation

and requires management practices to ensure compliance. The GO also specifies minimum setback requirements from wells and a minimum depth of groundwater at which monitoring would be required. Each RWQCB would have to consider all of the available information and data resources to ensure that general WDRs issued under the GO conform with the prohibitions and do not lead to water quality impairment. The SWRCB and individual RWQCB staff members are required to review discharger-provided information, evaluate site-specific conditions, and determine whether the proposed biosolids application project identified in an individual NOI would comply with the minimum standards of the GO. The databases and regulatory programs described above provide adequate resources for RWQCB engineers to make informed decisions on issuing a notice of applicability (NOA) for the project under the GO or rejecting the application (an NOA indicates that the proposed project can be permitted under the conditions of the GO). Given the full consideration of all available site-specific information for a proposed land application project, as specified in the NOI, and of other supplemental information and resources available to the RWQCB engineer, the RWQCB would not issue an NOA for the project if it could not ensure that the application project would comply with the GO.

As described above, various resources and programs are available with which to determine whether a project would result in violations of minimum standards specified in the GO. The SWRCB recognizes that individually prescribed fertilizer management practices should be specific to the unique crops, soils, and the potential risks to groundwater (California State Water Resources Control Board 1994).

The calculation of agronomic nitrogen uptake rates is becoming more fully integrated with complete farm fertility programs, and more environmental data are available to be used by certified crop advisors, agricultural engineers, agronomists, and other professionals in developing agronomic rates specific to local conditions and crop types. Agricultural water management plans required by state and federal programs have also been developed throughout the state and are intended to improve water conservation and reduce water demands. Farmland water management occurring as a result of these plans will also serve to reduce deep percolation of irrigation applied water and the potential for leaching of nitrates and other potential contaminants. Farm-level plans are currently not required in many areas of California. Several state and federal agencies maintain databases that provide real-time hydrologic and climatic information for optimal management of farm irrigation systems. This information is being made widely available through the agricultural industry by County Agricultural Commissioners, Agricultural Cooperative Extension, local water districts, resource conservation districts, and other state and federal agencies and as a result of the other programs described in the settings sections. The voluntary implementation of BMPs is being promoted as a means of reducing agrochemical contamination (California State Water Resources Control Board 1995b).

The activities to be undertaken as part of DHS's implementation of the DWSWAP Program, described above, will result in development of wellhead protection zones to protect groundwater and assess the vulnerability of municipal and domestic drinking water supplies that serve more than two service connections. (Single-connection residential wells are not part of the program.) The wellhead protection portion of the DWSWAP Program will include specific groundwater vulnerability analysis of all possible contaminating activities, including biosolids. In addition, local AB 3030 plans that characterize the local hydrogeology or have established wellhead protection programs and local requirements will also provide some assurance that groundwater assimilative capacities will not be exceeded. This impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Impact: Potential Degradation of Surface Water and Groundwater from Trace Elements in Biosolids

Biosolids application to land has the potential to contribute to surface runoff or to leachate beyond the plant root zone trace metals and other elements that could eventually reach groundwater. For water quality impacts to occur, the concentrations in surface runoff or subsurface leachate would have to exceed applicable regulatory water quality criteria (the lower of either ambient water quality criteria for aquatic life, human health from consumption of organisms, or drinking water standards) and result in toxic effects on the aquatic environment or impair beneficial uses of the water.

The GO contains numerous minimum standards that the discharger must implement to control surface water runoff from the application site. As described above, the potential for surface water runoff of biosolids is low because provisions of the GO would require dischargers to implement appropriate BMPs, such as maintaining minimum setback distances from surface waters and wells, prohibiting application directly to surface waters, prohibiting application to saturated or frozen ground or areas subject to washout, preventing runoff for the period within 30 days of application, and requiring that an erosion control plan be professionally prepared for areas with slopes greater than 10%. Consequently, the probability of washout is substantially reduced because biosolids application projects would have to be designed to meet the runoff prohibitions.

Potential impacts on groundwater quality were evaluated based on information developed for the Part 503 risk assessment process and other available data. The risk factors for increased leaching of trace metals from biosolids into groundwater increase under extreme soil pH conditions, high concentrations of trace metals in the biosolids or soil, and hydrologic conditions such as high rainfall or presence of shallow groundwater. In some areas in California, as described above, one or more risk factors are higher than under

typical conditions statewide. Low soil pH can exist in such areas as reclamation sites where acid drainage is present, some forest soils, and isolated regions of the Monterey and San Diego coastal regions. Some areas of the state have naturally high background concentrations of trace elements in the soil, such as selenium and boron in some southern San Joaquin Valley areas. Historical mine sites also may have high background levels of trace elements such as copper, zinc, mercury, lead, and cadmium, such as in northern California.

The potential impact of trace metals on groundwater quality is considered less than significant based on the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions that would result in low probabilities for water quality impairment. The following list describes types of impact mechanisms and mitigating factors and/or protections provided under the GO to reduce the potential impacts:

- Cultivated California soils generally have a neutral to alkaline pH (Holmgren et al. 1993), which thereby reduces the potential for trace metal mobility to the soluble phase. Over time, soil pH may become lower as a result of biosolids application, but there is no evidence that this condition increases metal mobility in soil. Low soil pH is a factor that needs to be considered by each RWQCB when evaluating proposed biosolids application projects. Each potential discharger would be required to submit soil pH data, and the RWQCB would evaluate the data for mine reclamation sites where pH conditions may be low as a result of acidic drainage water from mines. Some forest soils may also have lower pH than agricultural soils. RWQCB engineers would evaluate the information provided in each discharger's NOI to determine whether the application project is consistent with the GO prohibitions.

- The Part 503 risk assessment process for 14 contaminant pathways determined that the surface water and groundwater pathways were not limiting to any of the allowable trace metal concentrations or cumulative loading limits. The limiting pathway is the transport route for the contaminant in the environment that poses the lowest acceptable risk for application of biosolids to land. The risk assessments were conducted to evaluate risks from long-term application every year for 100 years as well as the risks associated with the total amount of metals that would build up in the soil after continuous application. Because biosolids applied under the GO would be tested for heavy metals, land application of biosolids for the entire 15-year period of the GO has a very low probability of exceeding risk thresholds for surface water and groundwater pathways that were developed using models that assumed application would continue for 100 years.

- The maximum concentrations of trace metals in sewage sludge produced in California, as reported in the recent 1998 CASA survey, indicate that most metals would comply with the proposed limits under the GO. Copper, mercury, and selenium are the only trace metals in the 1998 CASA data for which maximum reported concentrations would exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation. Consequently, some biosolids produced in the state would require additional treatment to be available for land application under the proposed GO.

- The proposed GO includes concentration limits and cumulative loading rates for chromium and molybdenum. The proposed GO is therefore more restrictive than the existing Part 503 regulations that do not include limits for these trace metals.

- A large percentage of metals are bound in the surface soil layers and are not mobile in the aquatic environment.

- Biosolids application is prohibited under wet or frozen conditions, thereby limiting potential infiltration and transport of dissolved trace metals to groundwater.

- Depth to groundwater during normal biosolids application periods in summer is typically sufficient in most regions of the state to preclude substantial transport of trace metals to the water table. Areas that could have shallow groundwater are distributed throughout California, but these conditions can generally be present in areas such as the southern San Joaquin Valley where confining layers restrict downward movement of groundwater, near natural groundwater recharge areas such as large regional low areas, and near streams. In areas with shallow groundwater and frequent biosolids application, monitoring is required that would result in early detection if leaching of substantial quantities of pollutants were occurring.

- There is a low probability that all the conditions suitable for metals transport would occur in California (i.e., high metals concentrations in biosolids, high biosolids application rates, low soil pH, and high rainfall conditions).

For the reasons described in this discussion, the impact of trace metals on surface water and groundwater is considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Impact: Potential Degradation of Surface Water and Groundwater from Synthetic Organic Compounds in Biosolids

Biosolids application to land has the potential to contribute SOCs to surface runoff or soil leachate beyond the plant root zone, which could eventually reach groundwater. For water quality impacts to occur, the concentration of runoff or leachate would have to exceed applicable regulatory water quality criteria (ambient water quality criteria for aquatic life, human health from consumption of organisms, or drinking water standards, whichever is lowest) or otherwise induce toxic effects in the aquatic environment. The potential for surface water runoff of biosolids is very low and the GO contains numerous minimum standards that the discharger must implement to control surface water runoff from the application site. As described above, provisions of the GO would require dischargers to implement appropriate BMPs, such as maintaining minimum setback distances from surface waters and wells, prohibiting application directly to surface waters, prohibiting application to saturated or frozen ground or areas subject to washout, preventing runoff for 30 days after application, and requiring that an erosion control plan be professionally prepared for areas with slopes greater than 10%. Consequently, the probability of washout is substantially reduced because biosolids application projects would have to be designed to meet the runoff prohibitions.

Potential impacts on groundwater quality were evaluated based on information developed for the Part 503 risk assessment process and other available data. The risk factors for increased leaching of organic compounds from biosolids into groundwater are based primarily on low soil organic matter content and microbial activity, high concentrations of organic compounds in the biosolids, and hydrologic conditions such as high rainfall or presence of shallow groundwater. In some areas in California, as described in the "Environmental Setting" section, one or more risk factors are higher than is the case under most conditions statewide. The major risk factors are related to hydrologic conditions that can contribute to increased groundwater concentrations such as the high rainfall areas of northern California and central coast, soils with low organic matter content (such as in some sandy soils), and shallow groundwater areas.

The potential impact of SOCs was evaluated based on the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions that would result in low probabilities for water quality impairment. The following information describes types of impact mechanisms and mitigating factors or protections provided under the GO to reduce the potential impacts:

- The Part 503 risk assessment process for 14 contaminant pathways determined that the groundwater pathway was limiting only for DDT/DDE compounds. EPA subsequently eliminated all SOCs from consideration in the final Part 503 regulations because they failed to meet one of three screening criteria described above. DDT/DDE compounds were eliminated based on all three screening

criteria. Consequently, land application of biosolids under the GO for 15 years has a very low probability of exceeding risk thresholds that were developed on models that assumed application would occur annually for 100 years.

- Organic compounds are generally strongly bound in the surface soil layers and are not mobile in the aquatic environment.

- Biosolids application is prohibited during wet or frozen conditions, thereby limiting potential infiltration and transport of organic compounds to groundwater.

- Depth to groundwater at the time of normal biosolids application during summer is typically sufficient in most regions of the state to preclude substantial transport of organic compounds to the water table. Areas that could have shallow groundwater are distributed throughout California but are generally areas such as the southern San Joaquin Valley, where confining layers restrict downward movement of groundwater, near natural groundwater recharge areas such as large regional low areas, and near streams. In areas with shallow groundwater, monitoring is required that would result in early detection if leaching of substantial quantities of pollutants were occurring.

- Although not regulated with pollutant concentration or annual cumulative loading rate limits, the GO contains narrative limits that the land application of materials classified as hazardous waste are not allowed. The lack of discharge limits for organic compounds in the GO does not imply lack of discharger responsibility to meet applicable federal and state hazardous waste disposal laws. In addition, testing and reporting are required as part of the NOI process in the GO rules for PCBs, the pesticides aldrin and dieldrin, and SVOCs. Existing federal and state hazardous waste laws would be applicable to biosolids application projects, and testing may be required; the existing Part 503 regulations do not require testing for any organic compound. The testing would provide a means of evaluating the potential for soil accumulation and transport of organic compounds at land application sites. If it is found in the future that the land application of biosolids is responsible for unlawful disposal of hazardous waste, cleanup actions (if required) would be taken by the responsible parties.

For the reasons described above, the impact of SOCs on surface water and groundwater quality is considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Impacts of Other Activities

## Horticultural Use

The use of biosolids for horticultural purposes (for turfgrass production, cut-flower production, road medians, parks, and golf courses) would result in similar or fewer impacts on soil and water resources compared to those described above for agricultural use because applicable minimum standards under the GO would be the same, and it is expected that horticultural operations would account for substantially fewer acres of the available biosolids application areas. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or horticultural uses because the same concentration and cumulative loading rate limits under the GO are applicable.

## Silvicultural Use

The application of biosolids for silvicultural use would generally result in impacts on soil and water resources similar to those described for agricultural use because applicable minimum standards under the GO would be the same. Biosolids application projects in forested areas, which tend to have greater slopes than urban and agricultural areas, may have slightly greater potential for runoff of biosolids during extremely wet weather conditions. However, each RWQCB is required to review each NOI for compliance with the minimum standards under the GO, and each discharger would be required to maintain the same setback distances from water bodies and wells, implement controls for surface runoff and storage of biosolids, and have erosion control plans for steep slopes. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or silvicultural uses because the same concentration and cumulative loading rate limits under the GO are applicable.

## Land Reclamation

The use of biosolids for land reclamation would generally result in impacts on soil and water resources similar to those described for agricultural use because most applicable minimum standards under the GO would be the same, and it is expected that land reclamation would account for substantially fewer acres of the available biosolids application areas. Biosolids application projects at land reclamation sites may have slightly greater potential for water quality impacts on nitrate-sensitive groundwater basins because the dry-weight application rates would not be limited by agronomic rate of nitrogen uptake. However, each RWQCB is required to review each NOI for compliance with the minimum standards under the GO, and each discharger would be

required to maintain the same setback distances from water bodies and wells, implement controls for surface runoff and storage of biosolids, and have erosion control plans for steep slopes. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or land reclamation sites because the same concentration and cumulative loading rate limits under the GO are applicable.

# Chapter 4. Land Productivity

# Chapter 4. Land Productivity

## Introduction

This chapter describes the potential impacts of biosolids applications on land productivity, including agricultural lands, forest lands, reclamation sites, and horticultural areas. Land productivity is the amount of biomass a soil and the associated climate can produce on a sustainable, long-term basis. For agricultural crops, land productivity is typically measured as the annual yield per acre (e.g., in bushels, pounds, or tons per acre). For grazing lands, productivity is normally measured in pounds or tons of forage per acre, but sometimes as the number of grazing animals per acre per month (animal-unit months) the land can support without deteriorating.

Inherent or native land productivity usually assumes normal agricultural management operations, not unusual operations such as installation of a tile drainage system, land leveling, or deep ripping of hardpans. These measures can greatly improve the productivity of certain marginal farmlands. Application of fertilizers or soil amendments can increase crop yields in the short term by compensating for deficiencies in soil nutrient status and taking advantage of the soil's ability to store added nutrients and transform them to bioavailable forms. Normal fertilization and soil amendment practices generally are not considered to have an effect on long-term land productivity when fertilizer and organic amendments contain low levels of heavy metal contaminants.

Land productivity can also be decreased or even eliminated by certain agricultural and grazing activities, excessive erosion of fertile topsoil layers, gullying, salt accumulation, and water table problems. Accumulation of phytotoxic compounds through incorporation of fertilizer or organic amendments containing heavy metal contaminants into the soil is another possible means by which land productivity becomes degraded (Witter 1996). Normally, application of fertilizers and soil amendments, including biosolids, that are not acutely toxic to plants would take long periods of time to accumulate in the soil in damaging quantities.

# Environmental Setting

As discussed in the setting section of Chapter 3, "Soils, Hydrology, and Water Quality", both the physical and chemical conditions of the soil determine the inherent productivity of a specific parcel of land. The chemical conditions of a soil include the level of native or inherent plant-available nutrients; the nutrient storage and supplying capacity of the soil; and the presence of phytotoxic substances such as heavy metals, boron, or soluble salts. Although adding fertilizers to land can improve plant yields, inherent productivity usually does not change because most fertilization effects are short lived. Vegetation management systems, plant types, other land management practices, and seasonal weather factors dictate the actual yield of land over the long term.

Soils also contain macro- and micro-organisms (e.g., small mammals, earthworms, bacteria) that have important functions in carrying out the biochemical processes and transformations that convert chemical compounds to bioavailable and mobile forms that can be taken up by plant roots. Important soil micro-organisms and beneficial soil insects may have different sensitivities to the presence of toxic compounds in soils than do plants, which can also vary greatly in their sensitivities to differing heavy metal concentrations in soils (McGrath et al. 1994, 1995; Cornell Waste Management Institute 1997).

# Impacts and Mitigation Measures

## Thresholds of Significance

The adoption of the proposed GO would have a significant impact on the environment if it would:

- cause substantial accelerated erosion and sedimentation;
- adversely and substantially affect soil productivity, yield, or quality; or
- cause a change in the land classification of a given area.

## Impacts of Agricultural Use

### Impact: Changes in Physical Soil Properties and Resulting Effects on Productivity

Application of biosolids to soil would increase the organic matter and organic carbon content of the soil; however, most of the organic matter contributed by biosolids is rapidly mineralized. Artiola and Pepper (1992) reported that 65% of the organic matter contributed by biosolids was mineralized within the first year. Resistant residual organic matter increased by 0.013% per year in that study. Aitken (1995) noted a 0.9% increase in organic carbon content over an 8-year biosolids application period. Over time, however, even resistant organic carbon content would decrease once biosolids applications have ceased. For example, Hyun et al. (1998) noted a 40% decrease in organic carbon content of the soil over a 10-year period after biosolids land applications ended.

Increased organic carbon content in soil from biosolids applications would result in the following beneficial effects on physical properties of the soil:

- increased water-holding capacity, particularly in soils already low in organic matter and in medium- to coarse-textured soils (a study conducted by Epstein [1975] found that applications of biosolids increased soil water retention) and

- reduced bulk density, particularly in fine-textured soils, because biosolids have a lower bulk density than most soils (Darmody et al. 1983).

Application of biosolids may temporarily impede soil infiltration and permeability by plugging soil pores. However, this temporary effect may be offset by the beneficial effect of decreased bulk density (National Academy of Sciences 1996). Soils with lower bulk density tend to be more permeable and have a higher infiltration capacity than soils with high bulk density.

A long-term, well-managed program of biosolids application would normally be expected to improve soil productivity, both over the short term and over the long term. In unusual circumstances (e.g., a clayey soil worked when too wet during biosolids incorporation), physical conditions of the soil could be adversely affected and yields could suffer. This is likely to be a short-term or transitory effect that subsequent proper soil tillage and management could correct. Because the potential for these adverse impacts on soil physical conditions is low, reversible, and manageable given the experience and capabilities of California farmers and ranchers, this impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

### Impact: Changes in Soil Fertility and Salinity and Resulting Effects on Productivity

Application of biosolids would increase the levels of nutrients and salts in the soil. Elements that would be added to the soil include nitrogen, phosphorus, potassium, calcium, magnesium, sodium, and chloride. All of these elements except phosphorus are water soluble and can be leached from upper soil layers. Phosphorus commonly is retained in the upper soil layers.

Soil pH would decrease as a result of the application of biosolids (Harrison et al. 1994). The pH decrease would result from the mineralization and nitrification of biosolids organic matter (Harrison et al. 1994, Emmerlich et al. 1982).

The soils' cation exchange capacity (CEC) would increase. This would be especially beneficial to coarse-textured soils with low organic-matter content. Agronomically appropriate applications of biosolids to farmlands generally have positive effects on plant growth and yield through the addition of plant nutrients (National Research Council 1996). Most biosolids contain both fast-release and slow-release forms of plant nutrients, as well as complex and stable organic fractions that improve the soil's ability to store nutrients. Therefore, the soil-fertility and plant-nutrient effects of a long-term, well-managed biosolids application program would generally be beneficial to agricultural soils and land productivity.

Several potential problems could arise, however, from implementation of the GO as currently proposed. For example, the proposed GO requires that land applications be based on agronomic rates for nitrogen (primarily to protect water quality) but does not provide direction or guidelines for management of other essential plant nutrients, such as phosphorus. The proposed GO has no requirement to balance biosolids applications with fertilizer additions of other plant nutrients. The GO also does not require that appliers or land managers develop a long-term view of biosolids as part of an overall soil-fertility and nutrient-management program. (Under similar circumstances, RWQCBs often require land-intensive livestock and dairy operators to develop overall nutrient management plans to control potential water quality impacts from their animal waste land-spreading operations.)

Under unusual circumstances, plant nutrition and soil fertility could be adversely affected by biosolids applications. For example, productivity could be adversely affected if biosolids applications create nutrient imbalances.

Similar to poor fertilization practices, such atypical problems could cause short-term to intermediate-term reductions in yields. In severe cases (e.g., long-term additions of biosolids with high carbon-nitrogen ratios or biosolids with lime-stabilized, low-bioavailable phosphorus), land productivity could be reduced, but this effect would be reversible once recognized. Recognition of complex fertility problems may not be within the experience or management capability of many California farmers, but assistance with potential problems would be available from the University of California (UC) Cooperative Extension or private agricultural and soil testing/agronomic consulting firms.

Although adverse crop productivity impacts from changes in soil nutrient and salt levels are unlikely to occur under the proposed GO, this impact is considered potentially significant. The following mitigation measure should be implemented to reduce this potential impact to a less-than-significant level.

**Mitigation Measure 4-1: Provide Soil- and Site-Screening Information with the Pre-Application Report.** The GO Pre-Application Report should be revised to require that WDR applicants provide sufficient soil and site information such that RWQCB staff can determine whether soils would be degraded and/or land productivity would be reduced as a result of biosolids application. In particular, providing the information is intended to ensure that 1) essential soil nutrients other than nitrogen are applied so that significant nutrient imbalances do not occur, 2) metals-related phytotoxicity does not occur, 3) metals related to forage toxicity or mineral deficiencies and other trace metals related problems do not occur on hay lands and pasture lands, 4) increases in salinity do not occur to the point that the yields of the crop(s) typically grown at the site is appreciably reduced, and 4) appreciable accelerated soil erosion does not occur.

The Pre-Application Report already requires sufficient information with which effects of potential nutrient imbalances, metals phytotoxicity, and excessive salinity can be analyzed. This information should be used by a certified soil scientist, or a certified agronomist to evaluate the above potential effects on land productivity. The soil scientist and/or agronomist should make recommendations in a letter report to accompany the Pre-Application report regarding the proper rate of biosolids applications, any soil management (such as supplemental fertilizers), appropriate crop, and grazing practice recommendations, considering the nature of the application site soils and biosolids characterization data, and the need to preserve short term and long term land productivity. The GO Pre-Application Report also should be amended to include the erosion hazard (derived from USDA soil survey reports[1]) of the proposed application site.

[1] Where a soils survey report is not available for a proposed application site, the applicant should have a qualified soil scientist determine the erosion hazard (using NRCS

Additionally, the following table should be added to the GO Pre-Application Report. Applicants or qualified soil scientists or agronomists should use the table to further determine whether soils could be degraded or land productivity reduced.

## Limitations to Land Application

| Parameter | Slight | Moderate | Severe |
|---|---|---|---|
| Cation exchange capacity[a] (average milliequivalents per 100 g, 0-20 inches depth | >15 | 10-15 | <10 |
| pH[b] (average 0-20 inches depth) | >6.5 | 5.0 to 6.5 | <5.0 |
| Erosion hazard rating[c] | None to slight | Moderate | High to severe |

[a] Cation exchange capacity limits based on professional judgment.
[b] pH limits based on U.S. Department of Agriculture (1993).
[c] Erosion hazard limits based on professional judgment.

Sampling of biosolids and soils should follow the procedures and protocols ~~specified in the National Sewage Sludge Survey (U.S. Environmental Protection Agency 1988)~~ currently approved by the EPA/DHS.

Provided that the applicant, a soil scientist, or agronomist has provided written confirmation to the RWQCB that soils would not be degraded and/or land productivity would not be reduced as a result of nutrient imbalances, metals-related phytotoxicity, or adverse salinity effects, biosolids may be applied on any site having a “slight” limitation as defined in the table. At sites having a “moderate” limitation, biosolids may be applied only where the crop is not known to be particularly sensitive to metals and nutrient imbalances, or is not known to be bioaccumulative of heavy metals. Sites having a “severe” limitation are excluded from eligibility under the GO and a site-specific waste discharge investigation and planning study should be conducted by a qualified soil scientist or agronomist to provide, in writing to the RWQCB, written confirmation that biosolids application would not cause soil degradation and would not reduce crop yield.

The GO and the Pre-Application Report also should be amended to specify an absolute upper slope limit of 20% at sites in which the biosolids would not be immediately covered by sod or a sufficient mulch cover to control erosion.

guidelines), unless the slope of the site is 3% or less. Sites with slopes of 3% or less will be considered to have a slight erosion hazard.

## Impact: Changes in Trace Elements and Heavy Metal Plant Toxicity in Soils and Resulting Effects on Productivity

Trace elements and heavy metals present in biosolids in elevated amounts and incorporated in agricultural soils can, under certain unique circumstances, have direct adverse effects on soil productivity by reducing crop yields and affecting crop quality and appearance (Schmidt 1997). Most California soils have a high capacity to bind up additional heavy metals, making them biologically unavailable. However, because California soils vary widely in their ability to attenuate or bind up heavy metals, and crops also vary widely in their sensitivity to bioavailable heavy metals in the soil-water solution, applications of biosolids at high rates onto certain combinations of soils and crops over the long term could result in potentially significant phytotoxicity problems. Leafy vegetables (e.g., lettuce, spinach) are often extremely sensitive to heavy metal phytotoxicity (Channey and Hundemann in U.S. Environmental Protection Agency 1992). These crops can be grown on sandy soils with low heavy metal-attenuating capabilities, such as some soils in the Salinas Valley, Central Valley, and Imperial Valley.

Phytotoxicity problems are normally expected to emerge slowly over time and, once recognized, to be managed accordingly. Because for most heavy metals bioavailability is pH-dependent, the most common management action would be to add lime to the acidic soils to bind or tie up the heavy metals in unavailable forms. Under this assumption, biosolids management relies almost entirely on the abilities of the farmer or rancher to recognize emerging phytotoxicity problems, correlate the problem with bioavailable heavy metals in the added sludge, and know that the management solution is to add lime to the soil and eliminate further biosolids applications. Some heavy metals, however, are not more bioavailable under acidic soil conditions, and self-management of problem soils would require that farmers also have a good general knowledge of soil chemistry and a working knowledge of how to diagnose and manage a range of phytotoxic heavy metals problems.

The degree of impact on crop productivity could range from negligible, with only a slight decrease in yield, to significant phytotoxic effects, with yield reductions of 10%-40% or more for certain highly sensitive crops (such as green leafy vegetables) and in certain soils with low native heavy metals-attenuation capabilities (such as the valley sandy soils mentioned above); this level of reduction could result ~~form~~from biosolids application levels that might be permitted under the federal Part 503 regulations and the proposed GO (Cornell Waste Management Institute 1997). The degree of impact is expected to correlate well with the heavy metal in question, the amount of bioavailable heavy metal in the biosolids, total cumulative loading amounts, the chemistry of the soil, soil management actions, and the crop. Potential impacts would likely occur only after years of biosolids heavy metals loading under the existing annual and total allowable loading limits. However, in some cases, farmlands could reach their maximum allowable heavy metals

loading limits (at which yield reductions would begin to be experienced) after 10 years of annual applications at the high end of the annual loading limits (California Farm Bureau 1998). Only certain soils (e.g., acidic and poorly managed) would be subject to yield reductions. Synergistic toxicity effects between heavy metals may also occur, making impacts more than additive in some cases.

The GO relies on the federal Part 503 regulations to minimize or control potential heavy metal-related impacts on agricultural soils and land productivity; it adds several new restrictions to reflect California's soil and crop conditions.

Some experts question the conclusions of the analysis conducted for the Part 503 regulations concerning the potential long-term effects on soil productivity from the presence of heavy metals in biosolids and their accumulation in soils after years of application at allowable rates. The allowable cumulative loading limits established in the Part 503 regulations are based on nationwide average soil conditions and do not conservatively reflect potential problems that could be encountered with some soil/crop combinations. Because it is difficult to effectively remove heavy metals from soil, permanent land degradation could result.

Considerable disagreement exists within the scientific and farming communities on this issue. Some of the controversy surrounds the fact that thorough research and long-term field trial information is not available on crop effects over the full range of soils and crop conditions where biosolids could be applied, making it difficult to accurately characterize the consequences of long-term biosolids heavy metals additions, particularly for atypical or unusual soil chemistry conditions, for sites that are managed poorly (in terms of tracking application rates, spreading sludge, and managing pH), or for specialty crops for which toxicity data do not exist.

The EPA analysis has been criticized for using average soil conditions and nonconservative assumptions when data were missing to complete the risk assessments for potential crop effects under the Part 503 regulations. This is a concern to some parties because California supports a wide variety of soils and crops that could be outside the range of conditions assumed by the EPA's risk assessment models.

The Part 503 regulations regarding heavy metals have been criticized for the following reasons:

- A relatively narrow range of soils and crops were considered by the EPA in evaluating potential impacts on crop yields and productivity. This range did not adequately reflect the range of soil and crop conditions found in California. Crops can vary widely in their sensitivity to heavy metals, and soils vary widely in their heavy metals attenuation ability.

- The Part 503 regulatory approach relies on projections of possible future quantities and types of heavy metals in the soil and amounts that may be phytotoxic under normal soil conditions and to typical crops, based on mathematical calculations of heavy metals in biosolids and estimates of loading. Estimation of average biosolids concentrations of total heavy metal levels, available heavy metals in soils after years of application, and biosolids application rates cannot in themselves be precise.

- There is no requirement to characterize soil conditions at a proposed biosolids application site for fertility, erosion hazard, or heavy metal-attenuating capability; track actual bioavailable heavy metals concentrations in the soils; or manage the soils to reduce phytotoxicity problems.

Properties and characteristics of soils that make them potentially subject to heavy metals toxicity problems include low pH, high sand content, low CEC, and low organic-matter content. The NRCS has recognized more than 1,700 soil series in California. An analysis of the NRCS soil database indicates that only a small proportion (perhaps 10%-15%) of California soil series have conditions that would lend themselves to potential problems under poor management and would therefore make them potentially susceptible to heavy metal bioavailability problems. However, biosolids have been land applied to California soils for more than 20 years in some areas and no significant land productivity problems related to heavy metals have been documented. Additionally, the proposed GO requires that cumulative loading limits for heavy metals at land application sites include the natural levels of heavy metals in the soil before application of biosolids.

Based on the above analysis, significant impacts relating to land productivity and heavy metals accumulation on agricultural soils could occur under the proposed GO for some combinations of California soils and crops and at poorly managed sites, but this circumstance would most likely be rare. The probability that the impact would not be widespread, however, does not reduce the potential for adverse effects in specific areas of California caused by the buildup over time of the bioavailable forms of heavy metals at phytotoxic levels in a small number of agricultural soil-crop combinations. Therefore, this impact is considered potentially significant.

Mitigation Measure 4-1 should be implemented to reduce this impact to a less-than-significant level.

## Impact: Changes in Amount of Synthetic Organic Compounds in Soils and Resulting Effects on Agricultural Productivity

No synthetic organic compounds (SOCs) are currently regulated under the Part 503 regulations or the proposed GO, although the proposed GO and existing state regulations require routine testing of biosolids for semi-volatile organic compounds, aldrin, dieldren, and polychlorinated biphenyls (PCBs). Testing for other organic compounds is conducted at the discretion of the producer and the RWQCB. Testing decisions are based, in part, on the characteristic industries within the treatment plant service area. No annual or cumulative loading limits have been established for SOCs; concentrations in biosolids are limited by general hazardous waste requirements contained in Title 22 of the California Code of Regulations. Sludge standards for PCBs, dioxins, furans, and perhaps polycyclic aromatic hydrocarbons (PAHs) and persistent pesticides are proposed for future development by the EPA (Cornell Waste Management Institute 1997). When adopted, these standards would automatically become a mandatory part of the state's biosolids management program.

Except in highly unusual situations, the presence of elevated levels of SOCs in soils as a result of biosolids application would not have a direct effect on soil productivity or crop yield because SOCs are typically not taken up by plants in measurable or phytotoxic quantities at concentrations normally found in biosolids. Human health or food quality effects, however, could result from plant uptake of low levels of SOCs that are not phytotoxic. This issue is addressed in Chapter 5, "Public Health". Direct impacts on agricultural soil productivity resulting from the presence of SOCs in biosolids are not expected, although impacts on the health of grazing animals could result from the use of biosolids high in SOCs if animals ingest soil directly during grazing.

Within Title 22 limits, high levels of SOCs originating from POTWs with industrial sources are still permitted in biosolids, adversely affecting populations of beneficial soil microorganisms and insects that may be more sensitive to these toxins than vascular plants (McGrath et al. 1994, 1995). Microorganisms assist plants in breaking down organic matter and using nutrients in various elemental transformations, such as the nitrogen cycle, and in direct uptake of plant nutrients through mycorrhizal bacteria. Although in some situations populations of soil microorganisms may be harmed by SOCs in soils, not enough information is available to conclude that biosolids with high SOCs would substantially damage soil productivity, particularly over the long term. The field of bioremediation of hazardous materials present in soils relies on the resiliency of soil microbial populations to eventually biodegrade SOCs and recover. The Title 22 regulations on hazardous waste establish upper limits for allowable levels of SOCs in materials that can be incorporated in soils. Many of these compounds would be expected to biodegrade over time when put in a soil environment with a good food source, such as the organic matter in the biosolids.

This potential impact is considered less than significant. (Note: An Oak Ridge National Laboratory [ORNL] study of biosolids SOC effects on soil microfauna is in progress.

The findings of that study could alter the conclusions of this analysis. Any proposed or final changes in the Part 503 regulations that result from the findings of the ORNL study would be reflected in required updates to the state's GO.)

**Mitigation Measures:** No mitigation is required.

## Impact: Changes in Grazing-Land Productivity

Grazing animals typically ingest some soil along with forage plants. Depending on variables such as the kind of animal, time of year, condition of pasture, method of biosolids application, and amount of time between application and use of fields by livestock, grazing animals could ingest 1%-30% of their total intake in soil matter (Fries 1996 as cited in Cornell Waste Management Institute 1997); therefore, compounds present in biosolids could be directly ingested by grazing animals in a variety of ways: from forage plants that have taken up compounds through their roots, from dust on the plants, and from the soil-biosolids mixture. (Concerns over potential human health risks associated with consuming meat from animals raised on biosolids-treated fields are addressed in Chapter 5, "Public Health".)

Agriculture-related impacts could result from two activities associated with long-term, excessive land applications of biosolids containing elevated levels of heavy metals or SOCs and from the subsequent ingestion by grazing animals of soils contaminated with heavy metals or SOCs:

- Nutritional deficiency or toxicity problems could become severe, acute, and lethal, causing mortality of animals and the corresponding devaluation of pastureland as unsuitable for grazing.

- Nutrition problems could occur that result in sublethal effects, including low animal weight, low reproductive success, or low milk yields (for dairy animals). Some of these problems could remain undetected.

Based on the present knowledge of typical California agricultural and rangeland soils and the common range of regulated heavy metals in biosolids, it appears unlikely that regulated heavy metals would accumulate in pastures to levels or at bioavailable concentrations that could substantially affect forage productivity or animal health. Such problems, should they occur from long-term heavy metal buildup, are likely to be relatively rare. Conversely, biosolids applied at appropriate rates should usually result in an improvement of pastureland productivity.

In spite of the proposed GO's provisions regarding regulation of heavy metals, there are specific conditions where extra care should be taken. Some California soils are naturally high in selenium (e.g., the soils of portions of western San Joaquin Valley), increasing the risk of selenium toxicity from combined native and biosolids sources. Both molybdenum and selenium can be present in soil at concentrations that are not detrimental to plant growth, yet be taken up by forage plants and result in concentrations in plants that are toxic to grazing animals (Cornell Waste Management Institute 1997). Unlike many other heavy metals, these elements can also be bioavailable at neutral to slightly alkaline soil pH levels.

The Cornell Waste Management Institute (1997) has concluded that the possibility of grazing animal toxicity problems occurring under the current Part 503 regulations (and therefore under the proposed GO) is real. The institute's research leads to the conclusion that the present database on soils, plant uptake, and biosolids composition is inadequate to assess the full magnitude of this potential problem.

Although the combination of circumstances that could lead to toxicity in grazing animals in California is probably only remotely possible, this impact is considered potentially significant. In addition to Mitigation Measure 4-1, the following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

**Mitigation Measure 4-2: Extend Grazing Restriction Period to Allow for SOC Biodegradation.** For grazing sites where biosolids applications are proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after land application. The GO should also be revised to require that grazing of animals be deferred for at least 60 days after application of biosolids ~~in areas with average daily (daytime) air temperatures exceeding 50ºF.~~ . Average daytime daily temperatures must exceed 50EF for 60 cumulative days. These measures will promote maximum biodegradation of SOCs and pathogens before grazing animals are exposed to the soil. Refer to Mitigation Measure 4-1, which requires comprehensive testing and analysis of soils and biosolids by qualified professionals.

## Impact: Increases in Soil Erosion Rates and Resulting Effects on Production

Soil erosion rates can accelerate when cultivated lands are disturbed by tilling operations, such as for biosolids incorporation, and the soil surface is left barren and unprotected from winter rains. This could occur at some erodible sites if biosolids are incorporated in the early fall and early, unseasonable rains occur before a protective cover crop becomes well established.

Severe, long-term soil erosion can affect agricultural productivity through loss of fertile and productive topsoil layers. In extreme cases, gullying can leave an area untillable. Most soil erosion on farmland is easily controlled through development and implementation of conservation tillage methods, proper water management, and use of cover crops.

The greatest hazard of erosion occurs on sloping lands. The proposed GO addresses this hazard by requiring that an erosion control plan be prepared by a qualified ~~erosion control specialist~~professional on slopes greater than 10%. No upper slope gradient limits are imposed. Some sandy California soils, however, are relatively susceptible to erosion on slopes as shallow as 5%-7% when tilled and left unprotected. Although incorporation of biosolids on erodible soils with slopes gentler than 10% would probably be rare in most areas of California, the sandy Dinuba and Delhi series soils (for example), which occur along the eastern San Joaquin Valley, are susceptible to erosion on slopes gentler than 10%. Incorporating biosolids on these or similar soils could result in locally significant impacts on soil resources.

Additionally, early season erosion may be difficult to control on steep land-application sites, even when an erosion control plan has been developed and implemented. Therefore, potentially significant accelerated erosion could occur on slopes of 20%-30% (i.e., the upper slope limit for using the wheeled farm machinery typically used to spread biosolids). The impact of erosion on farmland productivity is considered potentially significant. Mitigation Measure 4-1 should be implemented to reduce these impacts to a less-than-significant level.

## Impact: Changes in Farmland Classification

Agricultural lands are often classified by government agencies (such as the NRCS) according to their ability to produce crops, most often using a system based on a specific set of soil and site characteristics that influence or limit the ability of farmland to be cultivated or managed. Although farmland productivity issues have been addressed previously in this chapter for other impacts of the proposed GO, productivity effects that result in changes in the classification of certain farmlands could adversely affect farmers and agencies administering certain agricultural programs. For example, some U.S. Department of Agriculture programs (e.g., the Conservation Reserve Program) and state programs (e.g., the Williamson Act) use farmland classifications, such as prime farmland designations, to determine participation criteria and local funding levels for their programs.

Agricultural lands are classified using a variety of systems. Farmland classification systems, such as the U.S. Department of Agriculture's Land Capability Classification system, the University of California's Storie Index, and the California Department of

Conservation's Important Farmland Mapping and Monitoring Program, consider such factors as salinity, fertility, and toxicity.

Farmland classification systems recognize human impacts on land by considering land-improvement practices such as land leveling, drainage, and irrigation in determining farmland status. In severe cases, accelerated erosion can downgrade a land classification level.

Application of biosolids could affect the classification of specific farmlands in various ways, although changes in classification would probably be unusual. For example, over the long term, the incorporation of biosolids could improve productivity and bring marginal farmland into a higher land classification status. Conversely, heavy metals buildup in soils as a result of biosolids application could reduce a site's productivity and classification if it approaches phytotoxic levels. Similarly, severe cases of erosion caused by biosolids application on erodible soils or steep slopes could decrease the productivity of farmland and its farmland classification.

Although changes in farmland classification could occur under the proposed GO, this impact is considered less than significant because changes would most likely be rare and would not result in environmental impacts over and above those already evaluated in this chapter. Additionally, implementation of the mitigation measures recommended in this chapter would reduce effects that are likely to lead to changes in farmland classification by ensuring that toxicity and adverse soil fertility problems would not occur.

**Mitigation Measures:** No mitigation is required.

## Impact: Effect on Agricultural Lands Caused by Public Concerns about Crop Contamination from Biosolids Applications

Although accumulation of heavy metals and SOCs in soils as a result of biosolids application may affect crop yields only marginally, the productive value of farmlands may be reduced if consumers perceive that public health risks are associated with consuming crops produced on lands treated with biosolids. For farmlands on which biosolids have been applied and that have subsequently been poorly managed, farm operators could lose access to certain markets (e.g., the organic produce market, the food processing market) if crop contamination is perceived as a possibility by consumers or wholesale produce buyers.

Depending on public understanding and confidence in a biosolids regulatory program, the market exclusion could extend to most fresh produce originating from areas where biosolids have been extensively, but not comprehensively, applied. The problem could be

compounded if no regulatory requirement exists to track and publicly identify lands on which biosolids have been applied (including EQ biosolids) because produce buyers could suspect that biosolids were applied to all lands near biosolids application sites.

This crop contamination concern, whether real or perceived, could nevertheless have adverse effects on the ability of farm operators to effectively market their produce, thereby limiting the productive value of their land. Regulations that are seen by consumers, wholesale produce buyers, or food processors as ineffective in preventing problems, distinguishing lands with good biosolids management from poorly managed lands, or tracking lands to which biosolids have been applied could affect the overall market for agricultural produce within a given market area.

Regulations established by the GO need to be sufficiently conservative to not only deal with real problems of land productivity damage and concerns relating to public health and the environment, but also to address public perceptions and thereby protect the farmers' ability to sell agricultural commodities. A regulatory program that is based on typical or average conditions, and that does not address problems resulting from nontypical conditions, may cause all lands treated with biosolids or located near biosolids application sites, to come under suspicion of posing a health and safety hazard.

Several large wholesale produce and agricultural commodities buyers have already adopted policies precluding the purchase of crops from lands on which biosolids have been applied, apparently because of concerns over potential consumer reactions. This reaction to a perceived problem indicates that the impact on farmers of lost commodity markets is potentially significant. In addition to Mitigation Measures 4-1 and 4-2, the following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

**Mitigation Measure 4-3: Track and Identify Biosolids Application Sites.** A program to identify and track applications of biosolids on agricultural lands should be established to mitigate the potential perception by produce buyers and consumers that crops have been contaminated or damaged by biosolids applications. The program should allow for public access to information ~~on biosolids chemical characterizations, annual loading amounts, and monitoring data~~. The program should also identify previous biosolids incorporation sites and add them to the tracking system.

## Impacts of Other Activities

### Silvicultural Use

## Impact: Changes in Soil Nutrient Properties and Resulting Effects on Productivity

Less is known about specific biosolids impacts on forest soils, timber production, and silvicultural activities because biosolids research has focused on agricultural soils, common crops, and home garden uses. However, the same basic principles of soil science and agronomy used to evaluate potential biosolids impacts on agricultural soils also apply to forest soils.

Application of biosolids at mature forestlands is much more difficult than application on agricultural lands and therefore beneficial effects on physical soil properties may not be as common as those on agricultural and rangeland soils. The physical property benefits would be expected to be more significant on new forest plantation-type operations, where soil incorporation is easier. Similar to agricultural and rangeland soils, chemical effects associated with the fertilizer value of biosolids are expected to be common and primarily beneficial. Overall timber production and forest yield would be expected to increase in most situations following biosolids incorporation. Adverse nutrient interactions and induced deficiencies or improper forest tree nutrition (such as from very high soil nitrogen and low phosphorous levels) can potentially cause wood quality problems (e.g., poor wood strength) in some tree species, but this effect is also likely to be very rare and, once recognized, easily managed with an overall soil fertilization program.

California forest soils are more commonly acidic than agricultural soils, and therefore the bioavailability of phytotoxic heavy metals added with biosolids after many years of soil incorporation may be greater. Plants, however, vary widely in their sensitivity to heavy metals in the soil solution, with leafy vegetables presumed to be the most sensitive and most nonornamental woody plants the least sensitive. As with agricultural soils, potentially significant impacts on silvicultural sites, including reductions in forest productivity from soils with elevated heavy metals levels from long-term applications of heavy metals, particularly those not regulated under the 503 Rules, could occur under the proposed GO. Such impacts on forest soil are possible, but are most likely rare and would occur only in specific unusual conditions or combinations of unfavorable soil conditions and unusual biosolids chemistry. The chances of such an unusual combination of conditions occurring is increased under the proposed GO because it does not require complete testing of biosolids for all potentially phytotoxic heavy metals that could be added to forest sites. However, such adverse phytotoxicity effects on silvicultural operations are expected to be even more rare than for agricultural operations because of the presumed nonsensitivity of forest trees to heavy metals phytotoxicity in the soil concentration range expected to develop within the limits placed on biosolids loading. The impact is considered potentially significant. Mitigation Measure 4-1 should be implemented to reduce this impact to a less-than-significant level.

## Horticultural Uses

### Impact: Potential Soil Degradation at Recreation-Area Application Sites

Horticultural operations that may use biosolids include parks and golf-course landscaping, turfgrass production, cut flowers grown on small plots and container-grown landscape plants, and vegetable seedling plants for home-garden transplanting. Potential public health effects of horticultural uses are discussed in Chapter 5, "Public Health". Although flowers and leafy vegetables are often very sensitive to nutrient imbalances and heavy metals toxicity problems, which could affect yield, quality, and appearance, such problems are also more likely to be noticed by horticulturalists and more easily addressed through soil management (e.g., liming to adjust soil pH, switching to a nonbiosolids source of organic soil amendment). Additionally, only one application of biosolids as an organic amendment in container-grown stock would be permitted; therefore, the potential problems from long-term metals buildup in the soil from multiple applications would occur only in recreation-area applications. The scale of operation in container-grown crops and the economics of most field horticultural crops will allow for intensive observation and management. Accordingly, the general agricultural soil mitigation measures are applicable to only the recreation-area horticultural uses and no other mitigation measures are required. As with silvicultural operations, soil and soil-amendment testing would be prudent and in the best interests, but at the discretion, of the operator.

**Mitigation Measures:** No mitigation is required.

## Land Reclamation

### Impact: Potential Soil Degradation

Reclamation activities typically would include incorporation of biosolids into infertile soil materials, such as those from gravel-quarry waste or mine spoils. In reclamation site applications, the intent of the application is to improve soil conditions so that a vegetative cover can be established for soil stabilization. Occasionally, more intensive land uses might be considered as part of a reclamation project, such as a park or athletic field. A program for topsoil salvage and topdressing is often included in the reclamation plan. Where the goal is to establish high-quality turf over the reclamation site, a program combining topsoil importation and soil improvement through incorporation of amendments such as biosolids is often implemented. Incorporation of biosolids into such materials would improve both the physical and chemical condition of the materials and would be beneficial. Land productivity would almost always be increased. The reclamation or soil improvement program, as developed by most professionals, would normally include a soil-

and amendment-testing program, but one is not required under either the state Surface Mining and Reclamation Act, or the GO.

The proposed GO requirement differs for reclamation activities in that the biosolids do not necessarily need to be applied at agronomic rates for nitrogen, provided that impacts on water quality are managed. Maximum rates and annual and cumulative loading limits for heavy metals would still apply under the proposed GO. Heavy-metal phytotoxicity problems could occur in reclamation projects, affecting the growth of the cover crop. As with agricultural soils, the degree of heavy metal-plant impact is often related to pH. Because some mine spoils are extremely acidic from oxidation of pyritic compounds present in the rock waste materials, heavy-metal phytotoxicity may be more common at these sites. Often there may be a preexisting heavy metals phytotoxicity problem simply because of the inherent high level of heavy metals in the mine wastes or because of their acidity. In this case, biosolids applications can aggravate the problem, but also can be a part of spoils management and site stabilization, along with additions of other soil amendments, such as lime.

**Mitigation Measures:** Implement Mitigation Measures 4-1 and 4-2 described above for agricultural operations. This mitigation measure will reduce the impact to a less-than-significant level.

# Chapter 5. Public Health

# Chapter 5. Public Health

Chapter 5 analyzes the potential exposure of people to pathogenic microorganisms and other contaminants that may be present in both Class A EQ and Class B biosolids at levels that may cause disease. Pathogens (or pathogenic organisms) are disease-causing organisms, including certain bacteria, parasites, and viruses. Other contaminants—or "pollutants"—discussed in this analysis are (1) substances that are regulated under the GO in provisions that limit ceiling concentrations and cumulative loadings in biosolids and (2) other substances regulated under the California Health and Safety Code that may be found in biosolids in concentrations at which they could adversely affect human health; these include trace metals and synthetic organic compounds (SOCs). For purposes of the analysis, exposure to pathogens or pollutants is assumed to occur through:

- direct contact (direct ingestion or adsorption),
- inhalation, or
- ingestion of food
  - produced directly from soils amended with biosolids or
  - produced indirectly from such soils (i.e., consumption of animals or wildlife that consumed vegetation or crops growing in the soils).

The information in this chapter is based on:

- the quantitative risk assessments completed by the EPA to support the development of the Part 503 regulations limiting the beneficial reuse of sewage sludge (biosolids) (ABT Associates 1993),
- extensive review of the literature published since the completion of the Part 503 risk assessments to determine whether assumptions used in the risk assessments are still valid and whether new information is available that might change the evaluation of potential risks from use of biosolids, and
- review of state regulations pertaining to biosolids and consultations with qualified experts.

Controversy exists over the risk assessments performed by the EPA and whether the EPA's assumptions regarding appropriate level of risk are protective of public health (Harrison et al. 1999); questions regarding this issue are being addressed by the EPA and others. The National Research Council in 1996 assembled a panel of experts to assess the issue. The panel concluded that continued research on pathogen-monitoring techniques was needed, that restrictions on animals grazing on biosolids-amended fields should be reevaluated, and that the testing of sludges for the presence of toxics should continue so that the risk assessment assumptions can be refined as needed as better data become available (National Academy of Sciences 1996). It is not the purpose of this EIR analysis to resolve such controversies. This analysis addresses the effects of implementing a project: adoption of a GO that would allow for beneficial use of biosolids in California that is protective of public health, the environment, and water quality.

The EPA commissioned the National Academy of Sciences' National Research Council (NRC) to reassess the scientific basis of the Part 503 regulations and address public health concerns. Although this study recommended the resultant 2002 study Biosolids Applied to Land: Advancing Standards and Practices reviewed the regulations that govern the land application of biosolids from the following perspectives: (1) review the risk-assessment methods and data used to establish concentration limits for chemical pollutants in biosolids to determine whether they are the most appropriate approaches (including assessing how well EPA had responded to the recommendations of the 1996 assessment); (2) review the current standards for pathogen elimination and their adequacy for protecting public health; and (3) explore whether approaches for conducting pathogen risk assessment can be integrated with those for chemical risk assessment. Biosolids Applied to Land did not address the issues of dioxins or radioactivity in sewage sludge, both of which were the subject of separate analyses.

Biosolids Applied to Land concluded that while there is "no documented scientific evidence that the Part 503 rule has failed to protect public health … further research is needed to reduce persistent uncertainty about the potential for adverse human health effects from exposure to biosolids" (National Research Council 2002). The NRC offered almost 60 specific recommendations for addressing public concerns, scientific uncertainties, and data gaps in the science of biosolids application. The study's overarching recommendations for the EPA were to: (1) use improved risk-assessment methods to better establish standards for chemicals and pathogens; (2) conduct a new national survey of chemicals and pathogens in sewage sludge; (3) establish a framework for an approach to implement human health investigations; and (4) increase resources to EPA's biosolids program.

The EPA responded to these recommendations in a preliminary strategy published in the Federal Register of April 9, 2003. In its response, the EPA has pledged to: (1) update the scientific basis of Part 503 by conducting research in priority areas; (2) strengthen the

biosolids program by evaluating the results of completed, ongoing, and planned studies both inside and outside of EPA; and (3) continue ongoing activities to enhance communications with outside associations and the public over the Part 503 rules, to the extent that it is able to do so given budgetary constraints. (EPA. 2003)

The potential for biosolids to adversely affect groundwater underlying application sites or surface water adjacent to such sites is discussed in Chapter 3, “Soils, Hydrology, and Water Quality”. Potential impacts associated with inhalation of biosolids during application or tilling of soils where biosolids have been applied are analyzed in this chapter; however, the effects on air quality are discussed in Chapter 10, “Air Quality”. Effects on soils and crops are discussed in Chapter 4, “Land Productivity”.

This assessment focuses on the public health protection provided by the Part 503 regulations and the public health provisions of the proposed GO in light of the conditions that exist in California. It also considers whether there is new scientific evidence that warrants a reconsideration of the protections provided by these existing and proposed regulations. Finally, the assessment evaluates the need to modify any provisions or add other mitigation to protect public health.

On December 31, 2003, the EPA announced in the Federal Register its final action plan in response to the NRC recommendations arising from the Biosolids Applied to Land report. At the same time, it announced the results of its required review of existing biosolids regulations to identify additional toxic pollutants that may need to be regulated.

The final action plan identifies the following near-term projects to be initiated in the next two or three years (the final action plan uses the term "sewage sludge" to mean biosolids):

- biennial review under Clean Water Act Section 405(d)(2)(C);
- compliance assistance and enforcement actions;
- methods development, optimization, and validation for microbial pollutants in sewage sludge to improve the methods and procedures for determining the effectiveness of established pathogen reduction/elimination treatment processes;
- field studies of application of treated sewage sludge to determine whether the pathogen and chemical requirements of Part 503 are being met;
- targeted survey of selected chemical pollutants;

- participation in a workshop to be held by the Water Environment Research Foundation (WERF) to involve stakeholders in evaluating the next steps to develop an incident tracking process;

- exposure measurement workshop to compliment the WERF workshop;
- assess the quality and utility of data, tools, and methodologies to conduct microbial risk assessments on pathogens;
- support for the Pathogen Equivalency Committee;

- development and application of analytical methods for detecting pharmaceutical and personal care products in sewage sludge;

- publish the proceedings of the EPA-USDA workshop on emerging infectious disease agents and issues associated with animal manures, biosolids, and other similar by-products;

- support the February 2004 "Sustainable Land Application Conference;"

- review criteria for molybdenum in land-applied treated sewage sludge; and

- improve stakeholder involvement and risk communication.

The EPA has decided not to do two projects identified in its preliminary strategy (68 FR 17379) -- a re-evaluation of the risk assessment used for pollutants regulated or evaluated in Round One and a molecular pathogen tracking exposure study -- because of the ongoing studies identified in the final action plan, changing priorities, and limited resources.

Pursuant to the biennial review required under Clean Water Act Section 405(d)(2)(C), the EPA conducted screening analyses to determine whether there are additional toxic pollutants in biosolids that need to be regulated. Beginning with a list of 803 candidate pollutants (including pollutants already regulated), the EPA undertook a screening process to eliminate those that were either: already regulated; previously evaluated and not found to be a hazard; were not reported to be present in US sewage sludge in the literature; had no human health benchmark; or, is not the subject of another on-going assessment (those pollutants will be prioritized for possible inclusion in a targeted survey).

The EPA applied a hazard-based screening to the 40 pollutants identified after the initial screening. This looked at the potential exposure risks for three scenarios. As a result, the EPA identified 15 chemicals, which have hazard quotients that either exceed one for human receptors of equal or exceed one for ecological receptors. The EPA will undertake a more refined risk assessment and risk characterization process for these

chemicals. No specific new regulations are proposed at this time. A future rulemaking may be undertaken by the EPA, pending the completion of the risk assessment and characterization process and consideration of the results.

In addition, in a related action, the EPA submitted a written request to the Centers for Disease Control and Prevention on December 23, 2003 to review the available information on reported human health effects from the land application of biosolids. (U.S. Environmental Protection Agency. 2003x) The Biosolids Applied to Land report concluded that while there is no documented scientific evidence that the Part 503 rule has failed to protect public health, persistent uncertainty exists about the potential health impacts of land application of biosolids, and additional research and investigation are warranted. The EPA's request responds to the NRC report's recommendation that a protocol be established for systematic reporting, tracking, investigative follow-up, and data retention.

# Environmental Setting

## Introduction

This "Environmental Setting" section describes the pathogenic microorganisms that may be present in biosolids that could affect exposed hosts, inducing illness. The setting describes key disease-causing organisms and provides general information on their concentrations in biosolids; describes infectious doses (the numbers or concentrations of organisms that could induce illness in humans); and summarizes available information ~~in scientific~~ in scientific literature about their survival in soils, surface waters, and groundwater.

Summary data for the past few years are provided on the incidence of disease caused by known pathogens as reported by county and city health departments throughout California.

In addition, published reports on new disease outbreaks and newly discovered pathogens were reviewed. Emerging pathogens are organisms responsible for new, re-emerging, or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future. Included are such pathogens as *E. coli* O157:h7 and *Cyclospora*, which have caused several outbreaks in California. Because of a lack of cost-effective monitoring methods, pathogens in the environment are difficult to measure, but research laboratories are developing new

techniques for detection (De Leon et al. 1990, De Leon and Gerba 1990, De Leon et al. 1992, Straub et al. 1995, Droffner and Brinton 1995, Patel et al. 1998) Also, information on survivability and infectious dose is not yet available for these pathogens. Despite the paucity of information on emerging pathogens, however, some discussion of the diseases they cause and their potential presence is warranted, in part because it is important to note that new pathogens not normally present in California can be transferred (for example, by travelers or by importation of contaminated food or animals) at any time and can be introduced into the sewage system, and from there into biosolids. Where there are potential pathogens that pose risks that may be greater than those presently being reported, this information is noted.

Appendix E provides supporting information divided into three parts. ~~Refer to Appendix E (~~Part 1~~) for more~~ has detailed information on the individual pathogens and disease incidence in California. ~~Appendix E (~~Part 2~~)~~ contains a description of the EPA Part 503 risk assessment process, ~~which describes~~including the types of analyses undertaken to evaluate the risks of exposure to non-pathogenic contaminants and to establish the levels to protect public health that form the basis for the limitations established in the GO. Part 3 contains information on endocrine disruptors. The National Research Council's Biosolids Applied to Land: Advancing Standards and Practices examined the scientific basis for Rule 503, particularly from the point of view of the selection of chemicals and pathogens that are subject to Rule 503 and the effectiveness of the controls embodied in the rule.

## Pathogens

### Pathogens of Concern

Sewage and sewage sludges may contain a wide variety of pathogens shed by humans (who may or may not exhibit outward signs of any disease). This analysis addresses those pathogen groups that have been identified in scientific literature as being of regulatory concern or to which waterborne or foodborne disease outbreaks in our society (not necessarily related to biosolids) have been attributed. Tables 5-1 through 5-4 show the pathogens that have the greatest potential to be found in biosolids and that are currently pathogens of known health concern, and the diseases caused by the pathogens (U.S. Environmental Protection Agency 1985a, 1989a, 1989b, 1992a, 1992b, 1992c; Kowal 1985; Sorber and Moore 1987; Yanko 1988; Straub et al. 1993; ABT Associates 1993; National Academy of Sciences 1996; and Feachem et al. 1978). The tables do not list diseases that are unrelated to biosolids, which include toxoplasmosis (affects unborn fetuses, from cat feces, not many cases); polio virus, which no longer is a cause of disease in the Western Hemisphere; and cholera, which is rare. Also excluded was

## Table 5-1.
## Pathogenic Bacteria of Concern

| Name | Disease | Nonhuman Reservoir | Density in Biosolids (no/gm/dry wt) | Survival Time (days) | | | Infective Dose (Numbers of Organisms) |
|---|---|---|---|---|---|---|---|
| | | | | Soil | Crops | Surface Water | |
| *Escherichia coli* [pathogenic strains] | Gastroenteritis | Cattle | | 4-77 | < 3 weeks | 5-12 | |
| *Campylobacter jejuni* | Gastroenteritis | Cattle, dogs, cats, poultry | | | | | — |
| *Leptospira* spp. | Leptospirosis (Weil's disease) | Domestic and wild mammals, rats | | <15 | | | |
| *Salmonella* (>2000 types) | Typhoid, paratyphoid, salmonellosis | Domestic and wild mammals, birds, turtles | 3-103 | 11->259 | 2-53 | <16 | $10^3$-$10^8$ |
| *Shigella* spp. | Bacillary dysentery | | 20 | 26-77 | <2-8 | 1-<12 | |
| *Yersinia enterocolitica* | Yersiniosis (gastroenteritis) | Wild and domestic birds and mammals | $10^5$ | | | | |
| *Yersinia pseudotuberculosis* | Yersiniosis (gastroenteritis) | | | | | | |
| *Mycobacterium* | Tuberculosis | | | 90-450 | 10-49 | | |
| | | | | | 10->35 | <6 | |
| **Background Indicators** | | | | | | | |
| Total coliforms | | | 100-$10^6$ | | 6-35 | | |
| Fecal coliforms | | | 100-$10^6$ | | < 56 | | $10^6$-$10^8$ |

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

## Table 5-2.
## Pathogenic Viruses of Concern

| Name | Disease | Density in Biosolids (No/gm dry wt) | Survival Time in Days: Soil | Survival Time in Days: Crops | Survival Time in Days: Survival in Surface Water | Survival Time in Days: Groundwater | Infective Dose (Numbers of Organisms) |
|---|---|---|---|---|---|---|---|
| **Enteroviruses (General)** | | 0.2-210 (<2-0.8 MPN/mL liquid) | 15-180 | 4-23 | >188 | | |
| *Coxsackievirus viruses ( A & B)* | "Flu-like symptoms" | | Up to 180 | | 5-33 | | 1-10 |
| *Echovirus* | "Flu-like symptoms" | | | | | | 1-10 (10-100PFU) |
| Rotavirus | Acute gastroenteritis | 14-485 | | | | | |
| Norwalk virus | "Flu-like symptoms" | | | | | | |
| Adenovirus | "Flu-like symptoms" | | | | | | |
| Reovirus | "Flu-like symptoms" | | | | | | |
| Papovavirus | "Flu-like symptoms" | | | | | | |
| Astrovirus | "Flu-like symptoms" | | | | | | |
| Calicivirus | "Flu-like symptoms" | | | | | | |
| Coronavrius-Like Particles | "Flu-like symptoms" | | | | | | |
| Small round viruses (SRV) | "Flu-like symptoms" | | | | | | |
| **Other** | | | | | | | |
| Hepatitis A | Hepatits | | | | | >490 | 1-10 |
| Hepatitis B | Infectious hepatitis | | | | | | |
| Hepatitus E | Hepatitis | | | | | | |

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

## Table 5-3.
## Pathogenic Protozoans of Concern

| Name | Disease | Nonhuman Reservoir | Density in Biosolids (no/gm dry wt) | Survival Time in Days: Soil | Survival Time in Days: Crops | Survival Time in Days: Surface Water | Infective Dose (Numbers of Organisms) |
|---|---|---|---|---|---|---|---|
| **Human Pathogens** | | | | | | | |
| *Entamoeba histolytica* | Amebic dysentery, liver abcess, colonic ulceration | Domestic and wild mammals | | 8 | 4 | 2-6 | 10 cysts |
| *Giardia lamblia* | Giardiasis (Diarrhea, malabsorption) | Pigs and other mammals, cattle, feral hogs, coyotes, squirrels, and rats | 100-1000 | | | >16 | 10-25 cysts |
| *Cryptosporidium* | Cryptosporidiosis (Diarrhea) | Cattle, feral hogs, coyotes, squirrels, and rats | | | | | |
| *Balantidium coli* | Mild diarrhea, colonic ulceration | | | | | | 10 cysts |
| *Cyclospora Cayetamensis* | Cyclosporiasis (Severe diarrhea) | None known | | | | | |
| **Human Commensals** | | | | | | | |
| *Endolimax nana* | | | | | | | |
| *Entamoeba coli* | Amoebic dysentery | | | | | | |
| *Iodamoeba butschlii* | | | | | | | |
| *Isospora hominis* | | | | | | | |
| **Animal Pathogens** | | | | | | | |
| *Eimeria* spp. | | Fish, birds, mammals | | | | | |
| *Entamoeba* spp. | | Rodents, etc. | | | | | |
| *Giarida* spp. | | Dogs, cats, wild mammals | | | | | |
| *Isospora* spp. | | Dogs, cats | | | | | |

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

# Table 5-4.
# Pathogenic Helminths of Concern

| Name | Common Name | Disease | Nonhuman Reservoir | Density in Biosolids | Survival Time (days) | | | Infective Dose (Numbers of Organisms) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Soil | Crops | Surface Water | |
| **Nematodes (roundworms)** | | | | | | | | |
| *Ascaris lumbircoides (ova)* | Roundworm | Ascariasis | | 2-10 | 2-6 years | 27-35 | 540 | 1 egg |
| *Ascaris suum* | Swine roundworm | Ascariasis | Pig* | | | | | 1 egg |
| *Enterobius vermicularis* | Pinworm | Enterobiasis | | | | | | |
| *Trichuris trichiura (ova)* | Whipworm | Trichuriasis | | <1-3 | >35 | >18 months | | 1 egg |
| *Necator americanus* | Hookworm | Necatoriasis (anemia) | | | <4-6 months | | | 1 egg |
| *Ancylostoma duodenale* | Hookworm | Ancylostomiasis (anemia) | | | | | | |
| *Ancylostoma braziliense* | Curtaneous larva migrans | | Cat, dog* | | | | | |
| *Ancylostoma caninum* | Dog hookworm | Cutaneous larva migrans | Dog* | | | | | |
| *Stongyloides stercoralis* | Threadworm | Strongyloidiasis | Dog | | <35 | | | |
| *Toxocara canis* | Dog roundwaorm | Visceral larva migrans | Dog* | <1 | | | | 1 egg |
| *Toxocara cati* | Cat roundworm | Visceral larva migrans | Cat* | | | | | 1 egg |
| **Cestodes (Tapeworms)** | | | | | | | | |
| *Taenia saginata*** | Beef tapeworm | Taeniasis | | | | | 16-33 | 1 egg |
| *Taenia solium* | Pork tapeworm | Taeniasis, Cysticerosis | | | | | | 1 egg |
| *Hymenolepis nana* | Dwarf tapeworm | Taeniasis | Rat, mouse | | | | | 1 egg |
| *Echinococcus granulosus* | Dog tapeworm | Unilocular hydatid disease | Dog* | | | | | |
| *Echinococcus multilocularis* | | Alveolar hydatid disease | Dog, fox, cat* | | | | | |

* Eggs not infective for man.
** Definitive host; man only incidentally infested.

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

gastroenteritis (because of its general nature); AIDs because it is not associated with wastewater; and the fungal diseases, which are rare and not reported. Many more potential pathogens exist than are listed and, as noted above, new microbial pathogens are always being discovered.

Biosolids derived from the treatment of sewage sludge consist of a complex mixture of organic and inorganic compounds of biological and mineral origin removed from wastewater during primary, secondary, and tertiary sewage treatment (Straub et al. 1994). Properly treated biosolids meeting the pathogen-reduction and vector-control requirements of the EPA Part 503 regulations can still contain microorganisms that include bacterial, viral, protozoan, fungal, and helminth pathogens of potential concern to human and animal health (see Tables 5-1 through 5-4). The concern over any particular pathogen that may be present in biosolids is related to its ability to infect a host and cause disease. This ability depends on a wide variety of environmental factors (e.g., ability to survive wastewater treatment, longevity in the environment) and host-specific factors (sanitary habits, overall health, and any immune system impairments). Tables 5-1 through 5-4 list the specific disease organisms, diseases they cause, host organisms, and the infective dose (minimum number of organisms it takes to cause infection or induce illness) and provides other data on their measured concentrations in biosolids and viability in the environment (in soils, on vegetation, and in water). The listed pathogens can survive days (bacteria), months (viruses), or years (helminth eggs), depending on environmental conditions (Straub et al. 1994). The infective dose for some salmonella serotypes and other pathogenic bacteria is much higher than that of viruses and helminths and these organisms can multiply in high numbers when conditions are favorable (e.g., when a nutrient source such as a moist foodstuff is encountered). Viruses cannot multiply outside their hosts. The infective dose for *Salmonella sp*. varies by serotype and host factors.

Because individual pathogens cannot normally be detected or cannot be detected cost-effectively, indicator bacteria (such as the coliform group of bacteria) normally present in the human intestinal track are used as indicators of the presence of pathogens. For biosolids, the most favored group of indicators is *Salmonell*a, the most widely recognized enteric bacterial pathogen, with some 2,000 identified types. This species is responsible for some 1–2 million human disease cases a year in the United States (Straub et al. 1994). Fecal and total coliforms are normally used as indicators in wastewater and water samples and in contaminated soils.

It has been determined that the very young, the elderly, pregnant women, and the immunocompromised are at the greatest risk of serious illness and mortality from water and foodborne enteric microorganisms (Gerba et al. 1996). This segment of the population represents almost 20% of the population in the United States and is expected to continue to grow as the life span and number of immunocompromised individuals

increases. It has been reported that half the documented deaths from gastroenteritis and hepatitis A illness in developed countries occur in the elderly and that the case fatality ratio for foodborne bacterial gastroenteritis outbreaks in nursing homes is 10 times greater than that for the general population (Gerba et al. 1996). Pregnant women also have a tenfold greater case fatality ratio than the general public from hepatitis E infection during waterborne disease outbreaks. Enteric diseases have their greatest impact on the immunocompromised, with *Crytosporidium* posing a particularly serious problem for AIDS (acquired immune deficiency syndrome) carriers. Cancer patients and transplant patients are also at greater risk than the population in general. Children are particularly affected by rotovirus.

As an example of the unavoidable uncertainty associated with the impacts from pathogens in biosolids, the authors of the study "Hazards from Pathogenic Microorganisms in Land-Disposed Sewage Sludge," explain the following:

> It should be recognized that the list of pathogens is not constant. As advances in analytical techniques and changes in society have occurred, new pathogens are recognized and the significance of well-known ones changes. Microorganisms are subject to mutation and evolution, allowing for adaptation to changes in their environment. In addition, many pathogens are viable but nonculturable by current techniques [cite], and actual concentrations in sludge are probably underestimated. Thus, no assessment of the risks associated with the land application of sewage sludge can ever be considered to be complete when dealing with microorganisms. As new agents are discovered and a greater understanding of their ecology is developed, we must be willing to reevaluate previous assumptions.

## Emerging Pathogens of Concern

In most outbreaks of unknown cause or unknown source, a single or small list of organisms is normally suspected. If the causative agent is not identified or confirmed, it is because (1) the patient not seeking medical attention, (2) no laboratory diagnostic tests (including stool cultures and examination) are performed, and (3) either late or nonreporting of illnesses occurs that hinders the investigation of individual cases or outbreaks. Although most outbreaks are attributable to bacterial causes, limitations on our present diagnostic capabilities may also hinder a confirmatory diagnosis. New techniques using genetic markers and electron microscopy have improved laboratory capabilities to detect and identify pathogens, particularly viruses. There continue to be numerous sporadic cases of diseases (particularly gastroenteritis) of unknown cause or unknown source that arise and may be associated with a number of agents or sources. A literature review of disease outbreaks on a worldwide basis was performed to determine some of the emerging pathogens and their modes of transmission. The results of this search are summarized in Appendix E. The results indicated that the reported cases are normally associated with poor sanitation, poor food preparation and handling practices, or drinking contaminated water. Information on emerging pathogens of concern (bacteria, parasitic microsporidians, viruses, and bovine spongiform encephalophathy) is presented in Appendix E. These are in addition to those pathogens such as E. coli O157:h7 and Cyclospora that which have caused several outbreaks in California.

In October 2003, CBS News carried a story on the potential health risks of Staphylococcus aureas (S. aureas) in Class B biosolids. The report recounted the story of a Pennsylvania teenager whose parents blame his death from a staph infection on his exposure to neighboring farm fields to which Class B biosolids had been applied. This followed a September 2002 story in USA TODAY which had cited studies by Cornell University's Waste Management Institute that concluded that there is a connection between illnesses and the land application of biosolids and by researchers from the University of Georgia in Athens that concluded that there is a substantial risk of illness in residents in areas near where biosolids are applied.

S. aureas is a commonly found strain of staph that resides in the human nose, skin, and gastro-intestinal tract and is present in raw sewage. It can cause a variety of human illnesses, including skin and wound infections, food poisoning, septicemia, pneumonia, and toxic shock syndrome.

A discussion of the epidemiology of potential S. aureas infections is outside the scope of this EIR. However, the two studies that were referenced in the 2002 USA TODAY story exemplify the concerns being raised. Researchers at Cornell's Waste Management Institute investigated numerous incidents where residents living near biosolids application sites reported illnesses. They compiled information from 39 reported incidents in 15 states affecting more than 328 people through interviews with individuals and information

obtained from state health authorities and the U.S. EPA. Common symptoms included respiratory and gastro-intestinal disorders, skin diseases, and headaches (what the researches termed "sludge syndrome'). No testing was done of the sites from which the complaints arose. The study concludes that the amount of anecdotal evidence suggests that "contaminants coming from land application sites may pose an acute and immediate risk." The authors recommend better tracking of incidents and information sharing amount agencies, and a halt to the application of Class A and Class B biosolids to land pending definitive studies of the health effects. (Harrison. 2002)

The University of Georgia study interviewed 48 residents at 10 sites in the United States and Canada who had reported health problems they attributed to exposures to land-applied biosolids. They also reviewed the literature available on 5 other cases of illness. They found that interviewees commonly complained of irritation after exposure to winds blowing from fields to which biosolids had been applied. As with the Cornell study, no unexposed control group was included in the study. The University of Georgia study implicated biosolids in these illnesses, but concluded that it is "unknown, however, whether the strain(s) responsible for the infections had a common environmental source lasting for several years or if certain individuals or pets became persistent carriers and continued to expose others even after land application ceased." (Lewis. 2002)

While the above studies focused on anecdotal reports of illnesses, the University of Arizona National Science Foundation Water Quality Center reported in 2003 on its direct analysis of biosolids samples taken from 15 sites across the United States for the presence of viable S. aureas. These included 3 samples of raw, untreated sewage, 2 undigested primary sewage sludge samples, 23 different biosolids samples, and 27 aerosols obtained during the land application of biosolids. The sample sites were operating wastewater treatment facilities and agricultural lands where Class A and Class B biosolids were being applied in both the southwestern and northeastern United States. The analysis found S. aureas in samples of raw (untreated) sewage and undigested primary sewage sludge. However, no S. aureas was found in any of the samples taken from the land application sites, including airborne samples. The University of Arizona researchers concluded that "[t]hese results suggest that biosolids are not a significant source of S. aureas human exposure or source of S. aureas infection in humans." The researchers went on to raise a concern over studies of potential risk of illness that did not include "careful and rigorous confirmation steps for the identification of any bacterial pathogens." (Rusin. 2003)

## Incidence of Biosolids-Related Illnesses

Years of study and review by health scientists from a wide variety of disciplines went into the development of the EPA's Part 503 regulations. Subsequent to the adoption of

## Table 5-5.
## Summary of Biosolids Land Application in California 1998 (Ranked by Order of Land Applied Biosolids)

| County | Biosolids Land Application (dry tons/ year) | Permitted Acres[a] |
|---|---|---|
| Kern | 148,000 | 50,528 |
| Merced | 60,000 | 26,807 |
| Kings | 60,000 | 17,529 |
| San Diego | 45,297 | 4,000 |
| Riverside | 34,800 | 18,954 |
| Solano | 30,000 | 23,055 |
| Sacramento | 23,601 | 1,264 |
| Alameda | 13,887 | 1,920 |
| Sonoma | 11,540 | 4,520 |
| Tulare | 10,438 | 656 |
| San Joaquin | 7,418 | 2,210 |
| San Luis Obispo | 2,890 | 25 |
| Contra Costa | 2,200 | 1,480 |
| Shasta | 2,000 | – |
| Tehama | 1,569 | – |
| Fresno | 895 | 3,693 |
| Madera | 800 | – |
| Napa | 700 | – |
| Los Angeles | 400 | – |
| Humbolt | 332 | – |
| Santa Barbara | 300 | – |
| Placer | 240 | – |
| Tuolomne | 200 | – |
| Mendocino | 200 | – |
| Lassen | 180 | – |
| Calaveras | 8 | – |
| **Totals** | **457,895** | **156,641** |

[a] Permitted acres estimated from March 1997 report by Ray Kearney (City of Los Angeles staff) and does not necessarily correspond to land application quantities.

Sources: California Association of Sanitation Agencies 1999; Fondahl, Brisco, and Thurber pers. comms.

these regulations, studies have continued to evaluate the potential impacts on public health from biosolids management practices. To date, there have been no reported incidences of human disease that is directly related to biosolids land application operations (National Academy of Sciences 1996). A single recorded case of beef tapeworm transmission through the fertilization of land with untreated sludge has been reported in the United States (Hammerberg et al. 1978).

If any association between biosolids use and illness exists, it may be evidenced in an increase in reported incidences of illness in the existing areas of heaviest biosolids application. Most of the pathogens of concern, particularly viruses, induce flu-like symptoms or cause episodes of gastroenteritis that are of short duration and are not life threatening. Generally, fewer than 5% of gastroenteritis cases are reported (Gerba pers. comm.); therefore, existing data will not provide conclusive evidence of the degree of such a relationship but may nevertheless provide useful information.

Information on the acreages of land-applied biosolids in California counties was compared with data on reported disease outbreaks to determine whether any relationship between biosolids application and reported illness in California can be inferred. Table 5-5 shows quantities of applied biosolids in 1998 by California county in rank order along with the estimated number of permitted acres on which biosolids could be applied. Those counties not shown had no reported application of biosolids (there may have been negligible quantities applied, but they were not included in the totals).

Data on the diseases of interest (those listed in Tables 5-1 through 5-4) were obtained from the Department of Health Services (DHS) (descriptions of the diseases of interest are provided in Appendix E). These data consisted of records on reportable diseases that are provided by local county and city health departments (Starr pers. comm.). The diseases for which data were obtained are those with causative agents that could be derived from biosolids; therefore, certain diseases that were rare, not reported, or not related to biosolids were not included (AIDS, fungal diseases, and nonspecific gastroenteritis). The DHS information consisted of 46,159 records representing 300,818 cases of disease and covering the period from 1990 though 1998 for some diseases and 1992 to 1998 for Enterotoxic *E. coli* O157:h7. The information was sorted by county, year, and disease (and broken down by pathogenic organisms) and is presented in Tables E-1a and E-1b through E-16a and E-16b in Appendix E for the number of cases and the incidence rate per 100,000 people by county and summarized on a statewide basis by year in Table 5-6. The summary data show that the number of cases of a particular disease and incidence rates vary from year to year as conditions favor its occurrence in a particular population.

The incidence of diseases presented on a statewide basis in Table 5-6 are shown by county for the past 6-9 years (depending upon when the reporting was started for a

particular disease) in Tables 5-7 and 5-8. Also shown next to each county name (in parentheses) is the county's ranking in the state from the highest (1) to the lowest in terms of the amount of biosolids applied on land in that county in 1998. Table 5-7 contain a summary of the bacterial and viral diseases. Table 5-8 summarize the data on parasitic protozoan and helminthes diseases that are reported.

As noted in Table 5-5, the Central Valley counties of Kern, Merced, and Kings ranked first, second, and third in terms of the amount of biosolids that were land applied. The amounts applied were 32%,13%, and 13%, respectively, of the statewide total, or about 58% of the statewide total that was land applied.

The comparison of the number of reported outbreaks of acute infectious disease and the listing of counties where biosolids reuse occurs showed no apparent ~~correlation~~association between the highest biosolids use and any unusual illness outbreaks or patterns. Furthermore, discussions with public health officials and a review of available literature and discussions with other experts in the field revealed no reported disease problems associated with biosolids land application operations. Again, the types of diseases that might occur are not those that would normally be reported unless it was a severe case involving a visit to a doctor or hospital.

## Non-Pathogenic Contaminants

There are non-pathogenic contaminants in biosolids that could contribute to degradation of water quality if not properly managed in accordance with existing regulations governing the disposal of biosolids and the use of best management practices. A wide range of contaminants were evaluated during the development of the Part 503 regulations governing biosolids disposal and beneficial reuse (U.S. Environmental Protection Agency 1992b, 1994, 1995). Among those constituents of particular concern are those that might contaminate sources of drinking water and result in impairment of beneficial uses, including uses for potable supplies, which would result in direct impacts on public health. Any such impairments in quality could indirectly affect irrigation and livestock watering and, hence, crop and animal health. Included among these contaminants are nitrates, certain trace metals, selenium, salts, trace SOCs, and a large number of other compounds (200 were initially addressed in the EPA 503 rule development). A brief summary of health concerns related to these contaminants follows.

**Nitrates.** Of the public health issues related to contaminants that may be present in biosolids and affect water quality, perhaps the most important is the potential contribution of nitrates to groundwater. The mechanisms of transport and general subject

## Table 5-6.
## Summary of Reported Infectious Diseases in California 1993-1998
## (Years in which Data Were Available for All Diseases)

| | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| **Disease** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **Totals** |
| Amoebiasis | 237 | 175 | 163 | 223 | 125 | 127 | 1,050 |
| Campylobacteriosis | 931 | 864 | 914 | 2,477 | 1,136 | 903 | 7,225 |
| Cryptosporidiosis | 90 | 155 | 199 | 166 | 62 | 75 | 747 |
| Cryptosporidiosis (Type S) | 50 | 18 | 13 | 3 | 42 | 16 | 142 |
| Crytpossporidiosis Subtotal | 140 | 173 | 212 | 169 | 104 | 91 | 889 |
| Enterotoxic E-coli | 0 | 3 | 2 | 33 | 8 | 9 | 55 |
| Giardiasis | 1,089 | 821 | 693 | 1,335 | 858 | 510 | 5,306 |
| Hepatitis A | 874 | 953 | 1,079 | 1,300 | 1,415 | 725 | 6,346 |
| Salmonellosis | 1,153 | 1,498 | 1,311 | 1,894 | 1,292 | 1,010 | 8,158 |
| Shigellosis (Type A) | 14 | 8 | 5 | 17 | 0 | 5 | 49 |
| Shigellosis (Type B) | 439 | 796 | 435 | 348 | 251 | 196 | 2465 |
| Shigellosis (Type C) | 29 | 2 | 45 | 32 | 30 | 23 | 161 |
| Shigellosis (Type D) | 682 | 469 | 873 | 625 | 388 | 397 | 3434 |
| Shigellosis (Unidentified Type) | 116 | 105 | 172 | 178 | 62 | 80 | 713 |
| Shigellosis Subtotal | 1,280 | 1,380 | 1,530 | 1,200 | 731 | 701 | 6,822 |
| Tapeworm (Taenia) | 2 | 6 | 5 | 0 | 1 | 14 | 28 |
| Toxoplasmosis | 42 | 9 | 28 | 23 | 18 | 9 | 129 |
| Viral meningitis | 425 | 181 | 119 | 188 | 186 | 403 | 1,502 |

Source: Starr pers. comm.

## Table 5-7.
## Summary of Reported Infectious Disease Cases (Bacterial and Viral) by County
## 1991-1998

| Health Department Reporting[a] | Salmonellosis Six Year Totals | Campylobacteriosis Six Year Totals | Enterotoxic-E-coli Six Year Totals | Shigellosis Total for All Six Year Totals | Hepatitis A Eight Year Totals | Viral Meningitis Eight Year Totals |
|---|---|---|---|---|---|---|
| Long Beach (City) | 508 | 442 | 6 | 620 | 874 | 300 |
| Los Angeles (19) | 6735 | 5306 | 33 | 5281 | 5934 | 1502 |
| Pasadena (City) | 143 | 131 | 1 | 144 | 150 | 28 |
| San Francisco | 8 | 21 | 1 | 389 | 151 | |
| Alameda (8) | 280 | 537 | 9 | 150 | 56 | 3 |
| Amador | 3 | 12 | | | 3 | |
| Butte | | 1 | | | 1 | |
| Calaveras (26) | 5 | 11 | | | | |
| Colusa | 3 | 2 | | 2 | 4 | |
| Contra Costa (13) | 1 | | | | 8 | 4 |
| El Dorado | 5 | | | 2 | 12 | |
| Fresno (16) | 7 | 15 | | 18 | 18 | 13 |
| Glenn | 6 | 4 | | | 3 | 1 |
| Humboldt(20) | | | | | 6 | |
| Imperial | 40 | 19 | | 43 | 27 | 3 |
| Inyo | 6 | 6 | | 1 | | |
| Kern (1) | | | | | 19 | 2 |
| Kings (3) | | | | | 4 | |
| Lake | 8 | 5 | | | 3 | |
| Lassen (25) | 4 | 4 | | 2 | 1 | 2 |
| Marin | 35 | 167 | 1 | 15 | 1 | 7 |

| Health Department Reporting[a] | Salmonellosis Six Year Totals | Campylobacteriosis Six Year Totals | Enterotoxic-E-coli Six Year Totals | Shigellosis Total for All Six Year Totals | Hepatitis A Eight Year Totals | Viral Meningitis Eight Year Totals |
|---|---|---|---|---|---|---|
| Mariposa | 2 | 3 | | | 20 | |
| Mendocino (24) | 1 | 3 | | | 8 | 1 |
| Merced (2) | | | | | 14 | |
| Modoc | 1 | 3 | | 2 | 1 | |
| Monterey | | 2 | | | 1 | 3 |
| Mono | 16 | | | 1 | 15 | |
| Napa (18) | | | | | 2 | 3 |
| Orange | 159 | 160 | | 43 | 180 | 187 |
| Placer (22) | 4 | 1 | | | 5 | 1 |
| Plumas | 6 | 2 | | | | |
| Riverside (5) | | | | | 31 | 22 |
| Sacramento (7) | 2 | 86 | | | 38 | 11 |
| San Benito | 7 | 18 | 1 | 20 | 46 | |
| San Bernardino | 4 | 5 | | 3 | 0 | 11 |
| San Diego (4) | 5 | 6 | 1 | 6 | 79 | 46 |
| San Joaquin (11) | | | | | 1 | 1 |
| San Luis Obispo (12) | 1 | | | | 1 | 1 |
| San Mateo | | | | | 8 | 3 |
| Santa Barbara (21) | 1 | | | | 2 | |
| Santa Clara | 2 | 3 | | | 19 | 3 |
| Santa Cruz | 60 | 100 | 1 | 28 | 13 | 11 |
| Shasta (14) | 6 | 9 | | 3 | 13 | |
| Sierra | | 1 | | | | |
| Siskiyou | | 13 | | | 4 | |

| Health Department Reporting[a] | Salmonellosis Six Year Totals | Campylobacteriosis Six Year Totals | Enterotoxic-E-coli Six Year Totals | Shigellosis Total for All Six Year Totals | Hepatitis A Eight Year Totals | Viral Meningitis Eight Year Totals |
|---|---|---|---|---|---|---|
| Solano (6) | | | | | 1 | 1 |
| Sonoma (9) | | | | | 7 | 1 |
| Stanislaus | | | | | 9 | |
| Sutter | | | | | 1 | |
| Tehama (15) | 5 | 2 | | 1 | 3 | |
| Trinity | | 3 | | | 1 | |
| Tulare (10) | 68 | 115 | 1 | 45 | 65 | 9 |
| Tuolumne | 11 | 7 | | | 1 | 1 |
| Ventura | | | | 1 | 6 | 3 |
| Yolo | | | | | 1 | |
| Yuba | | | | | 3 | 1 |
| Total Number of Reported Cases | 8158 | 7225 | 55 | 6693 | 7874 | 2185 |

[a] All are county health departments except City of Long Beach and City of Pasadena.

Source: Starr pers. comm.

# Table 5-8.
# Summary of Reported Infectious Disease Cases (Parasitic, Protozoan, and Worm) by County 1991-1998

| Health Department Reporting[a] | Cryptosporidiosis Total Eight Year Totals | Amoebiasis Six Year Totals | Giardiasis Six Year Totals | Toxo-plasmosis Six Year Totals | Tapeworm (Taenia) Six Year Totals |
|---|---|---|---|---|---|
| Long Beach (City) | 77 | 91 | 671 | 6 | |
| Los Angeles (19) | 875 | 898 | 3832 | 121 | 26 |
| Pasadena (City) | 13 | 4 | 133 | 1 | 2 |
| San Francisco | 22 | 13 | 9 | | |
| Alameda (8) | 1 | | 152 | | |
| Amador | | | 8 | | |
| Butte | | | | | |
| Calaveras (26) | | | 12 | | |
| Colusa | | | 2 | | |
| Contra Costa (13) | | | 1 | | |
| El Dorado | | | 1 | | |
| Fresno (16) | 1 | | 21 | | |
| Glenn | | | 5 | | |
| Humboldt (20) | | | | | |
| Imperial | | | 10 | | |
| Inyo | | | | | |
| Kern (1) | 1 | | | | |
| Kings (3) | | | | | |
| Lake | | | 14 | | |
| Lassen (25) | | | 5 | | |
| Marin | 3 | 30 | 75 | | |
| Mariposa | | 1 | 2 | | |
| Mendocino (24) | | | 2 | | |
| Merced (2) | | | | | |
| Modoc | | | 1 | | |
| Monterey | 4 | | | | |
| Mono | | | 1 | | |
| Napa (18) | | | | | |
| Orange | 19 | 3 | 177 | | |
| Placer (22) | | | 2 | | |
| Plumas | | | 4 | | |
| Riverside (5) | 1 | | | | |
| Sacramento (7) | 1 | 6 | 63 | | |
| San Benito | | | 6 | | |
| San Bernardino | 3 | | 5 | | |
| San Diego (4) | 3 | | 6 | 1 | |

# Table 5-8. Continued



| Health Department Reporting[a] | Cryptosporidiosis Total Eight Year Totals | Amoebiasis Six Year Totals | Giardiasis Six Year Totals | Toxo-plasmosis Six Year Totals | Tapeworm (Taenia) Six Year Totals |
|---|---|---|---|---|---|
| San Joaquin (11) | | | | | |
| San Luis Obispo (12) | 1 | | | | |
| San Mateo | 1 | | | | |
| Santa Barbara (21) | | | 1 | | |
| Santa Clara | 1 | 2 | 1 | | |
| Santa Cruz | | | | | |
| Shasta (14) | | | 4 | | |
| Sierra | | | 1 | | |
| Siskiyou | | | 3 | | |
| Solano (6) | | | | | |
| Sonoma (9) | 1 | | | | |
| Stanislaus | | | | | |
| Sutter | | | | | |
| Tehama (15) | | 1 | 9 | | |
| Trinity | | | 3 | | |
| Tulare (10) | | 1 | 59 | | |
| Tuolumne | | | 5 | | |
| Ventura | | | | | |
| Yolo | | | | | |
| Yuba | | | | | |
| Total Number of Reported Cases | 1028 | 1050 | 5306 | 129 | 28 |

[a] All are county health departments except City of Long Beach and City of Pasadena.

Source: Starr pers. comm.

of nitrates has been addressed in Chapter 3, "Soils, Hydrology, and Water Quality". Nitrates are relatively nontoxic to humans when ingested with water or food unless they are converted to nitrite, which can enter the bloodstream and bind with hemoglobin to form methemoglobin, a condition known as methemoglobinemia, which reduces the blood's oxygen-carrying capacity. The disease affects infants (generally those less than 6 months of age) because their gastric juices are more nearly neutral than those of adults (which have an acidic balance), resulting in nitrate reduction to nitrite being more prevalent. Methemoglobinemia is an extremely rare affliction with few reported fatalities. Only about 2,000 cases have been reported in the United States over the 30-year period since the disease was first reported (National Academy of Sciences 1988).

The EPA (in 1975) and the State of California (1989) have adopted drinking water standards of 45 mg/l (or parts per million [ppm]) nitrate (or 10 mg/l nitrate nitrogen) based on the first (1962) U.S. Public Health Service standard, which established 45 mg/l of nitrate in water as a warning level at which to avoid using water for feeding infants. Surveys of the scientific literature have found no cases of methemoglobinemia reported in the United States when water contained less than 45 mg/l of nitrate (10 mg/l nitrate nitrogen) (Winneberger 1982).

Another concern is the chemical reaction in which, under certain conditions, nitrate reacts with other compounds to form N-nitroso compounds, many of which are potent carcinogens. No health-related problems related to nitrates in biosolids were found during the literature review or discussions with health officials in California.

**Metals.** Health effects on humans associated with the presence of metals in water are addressed by the adopted water quality standards for surface waters and groundwater that protect the various designated beneficial uses. Health effects are avoided by the maintenance of water quality such that drinking water standards are not exceeded.

**Selenium.** Health effects resulting from selenium ingestion by humans are not well documented. The EPA risk assessment for land application of biosolids established the pollutant limits for selenium based on a child eating biosolids. The health effect resulting from exceeding the reference concentration for selenium is unknown. Studies of animals show that selenium can be lethal at high dosages and is a carcinogen in animals.

**Salts.** Increases in dietary salt in humans via water or foods are associated with an increase in heart disease, but the levels of concern and effects are still under debate.

**Organics.** Neither the EPA nor the SWRCB has placed limitations on the levels of SOCs in biosolids because SOCs were not found to pose a risk to health at the concentrations at which they are found in biosolids (U.S. Environmental Protection Agency 1995).

**Endocrine Disruptors.** The list of known and suspected hormone disruptors (pollutants with widespread distribution reported to have reproductive and endocrine-disrupting effects) include the following (after Colborn and Clement 1992, Colborn et al. 1993):

- Persistent organohalogens - dioxins, PCBs, furans, hexachlorobenzene,and pentachlorophenol
- Pesticides - 2,4,5-T,2,4-D, atrazine, benomyl, beta-HCH, chlordane, DDT and metabolites, endosulfan, lindane, heptachlor, h-epoxide, malathion, toxaphene, and many others
- Phenolic compounds - phthalates, such as di-ethylhexyl phthalate (DEHP), and many others
- Other organics - styrene dimers and trimers, benzo(a)pyrene
- Heavy metals - cadmium, lead, and mercury

All of the substances presently identified as hormone disruptors are now widely distributed throughout the environment, some are common constituents of consumer products, and many are now found in human tissues and have been shown to affect the health, reproduction, and behavior of animals.

Although trends in hormone-related diseases have not been clearly linked to environmental chemicals, it is probable that endocrine disruptors are contributing to human diseases and disfunction (Ankley et al. 1997). The EPA, through the 1996 reauthorization of the Safe Drinking Water Act, was directed to address possible endocrine disruptors in drinking water. The White House convened an interagency task force of national experts to improve the national response to the issue and evaluate consumer exposures, workplace exposures, and facility releases of chemicals, including the use of biosolids in land application (Ankley et al. 1997).

These “endocrine disruptors” include both natural compounds and synthetic chemicals. Some, called phytoestrogens, occur naturally in a variety of plants. Of current concern are the synthetic estrogens produced either through industrial manufacture or as byproducts of such processes or burning. Some of these have been found to speed the

growth of cultures of breast cancer cells, raising questions about human health effects (Felsot 1994, MacMahon 1994, and Safe 1995). The effects have been detected at chemical concentrations of parts per trillion, levels at which most chemicals have never been tested.

**Dioxins.** Dioxins refers to a family of chemical compounds formed by the burning of chlorine-based chemical compounds. Dioxins occur commonly in the environment as a result of incineration and industrial practices. The most common health effect in people exposed to large amounts of dioxin is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other effects of exposure to large amounts of dioxin include skin rashes, skin discoloration, excessive body hair, and possibly mild liver damage. One of the main health effects in question for dioxins is the risk of cancer in adults. Several studies suggest that workers exposed to high levels of dioxins at their workplace over many years have an increased risk of cancer. Animal studies have also shown an increased risk of cancer from long-term exposure to dioxins. Finally, based on data from animal studies, there is some concern that exposure to low levels of dioxins over long periods (or high level exposures at sensitive times) might result in reproductive or developmental effects. (Interagency Working Group on Dioxin. October 2003)

Part 503 was promulgated in February 1993. EPA was required by a court order to promulgate a second round of Part 503 regulations by December 2001. Accordingly, the EPA conducted a screening for pollutants and concluded that the only pollutants posing a potential risk that were not regulated in the first round of regulations were dioxin and dioxin-like compounds. In late 1999, the EPA initiated a rulemaking to consider the regulation of the use and disposal of sewage sludge containing dioxins in biosolids. In the fall of 2003, after considerable research and risk assessment modeling, the EPA concluded that dioxins from biosolids do not pose a significant health risk to humans. The 2001 Dioxins Update to EPA's National Sewage Sludge Survey found that dioxin levels in treated sewage have declined since the last EPA survey in 1988.

The EPA's study considered those individuals most highly exposed to the dioxins (a theoretical farm family that applies sewage sludge to its land and whose members consume a high percentage of their own agricultural products) and found that only about 0.003 new cases of cancer would be expected each year, or 0.22 new cases of cancer over a lifespan of 70 years. The cancer risk to the general population would be even lower than this due to a lower exposure. As a result, on October 17, 2003 the EPA decided that no numeric limits or management practices for dioxin are required to adequately protect human health and the environment from the adverse effects of dioxins in land-applied biosolids. (EPA 2003) Therefore, no change to Part 503 resulted from this rulemaking.

**Radioactivity in Sewage Sludge.** The Sewage Sludge Subcommittee of the federal Interagency Steering Committee on Radiation Standards (ISCORS) issued three reports on this issue in late November 2003. ISCORS is made up of the EPA, Nuclear Regulatory Commission, Department of Energy, Department of Defense, Department of Transportation, Occupational Safety and Health Administration, and Department of Health and Human Services. Its purpose is to facilitate the coordination and resolution of regulatory issues associated with radiation risk to the public and workers, and the establishment of radiation standards. The Sewage Sludge Subcommittee was formed to examine the prevalence of radionuclides at publicly owned treatment works (POTWs) and the level of potential threat posed to human health and the environment by various levels of such materials, in response to a 1994 General Accounting Office Report that cited a number of cases where radionuclides were discovered in sewage sludge and ash.

ISCORS Assessment of Radioactivity in Sewage Sludge: Radiological Survey Results and Analysis summarizes the results of the testing of sewage sludge and ash from 313 POTWs around the country for radioactivity. The POTWs were selected for inclusion in the survey were those with the greatest potential for having detectable levels of radioactive materials. Samples from the POTWs were tested for both naturally-occurring and man-made radioactive materials. Naturally-occurring materials exist in soil and water and may enter a plant from industrial and water-treatment sources. Man-made radioactive materials typically enter a POTW through authorized releases allowed under federal or state license (most commonly medical diagnosis and treatment materials). The sample was intended to offer a snapshot of levels, not to characterize the sludge from any particular POTW. The authors concluded that the results of this non-random survey, of a limited number of POTWs, did not indicate that there is a widespread or nationwide public health concern. (Interagency Steering Committee on Radiation Standards. November 2003b.)

ISCORS Assessment of Radioactivity in Sewage Sludge: Modeling to Address Radiation Doses, is a draft report assessing the potential levels of radiation doses to people by modeling seven scenarios for the movement of radioactivity from sludge into the local environment. Scenarios included residents of homes built on agricultural fields formerly applied with biosolids, residents of a town near fields where biosolids are being applied, workers at a POTW, and agricultural workers who operate equipment to apply biosolids to agricultural lands. The radionuclides modeled in this report were selected based on the results of the survey.

The preliminary conclusions of this report include the following:

- none of the non-POTW scenarios show a significant current widespread threat to public health;

- if agricultural land application is carried on for a long time into the future, then the potential exists for future radiation exposure of on-site residents, primarily due to Radon (50 and 100-year scenarios);

- when there are very high levels of radioactive materials, there is the potential for localized radiation exposure; and

- within a POTW, there is a potential for significant exposure of workers to radon when they are in the same room with large quantities of sludge and the room is small and poorly ventilated.

The report found that for both on-site residents and POTW workers, "exposure can be decreased radically through the use of readily available radon testing and mitigation technologies." (Interagency Steering Committee on Radiation Standards. November 2003a.)

ISCORS Assessment of Radioactivity in Sewage Sludge: Recommendations on Management of Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works is a draft report recommending further actions that may be taken by POTW operators whenever elevated levels of radionuclides are detected at the POTW. While the document states that it does not constitute a rule making or formal guidance on this subject, it does offer a number of suggestions to POTWs relative to screening for the presence of radionuclides in the wastestream based on the presence of natural and man-made sources; consultation with federal and state agencies that regulate the release of radionuclides (for example, the California Department of Health Services' Radiological Health Branch); and actions reducing worker exposure. The authors of the report recommend using a threshold of 10 millirems/year or greater as the level of exposure that should trigger the POTW to consult with its state regulatory agency to determine if additional analyses should be conducted and responses need to be taken. (Interagency Steering Committee on Radiation Standards. November 2003c.)

The latter two reports are available for public comment until February 6, 2004.

## Incidence of Chronic Disease in California Related to Non-pathogenic Contaminants

Diseases that are associated with general environmental exposure to toxic pollutants or other environmental contaminants are not well reported and the causes are difficult to pinpoint, even at some of the more infamous sites of exposure, such as the Love Canal in New York or other hazardous waste sites where high levels of contaminants can be found. At very low levels, such as those found in biosolids or in foods, the risks are

measured in terms of a lifetime of chronic exposure. Such risk assessments have been performed by the EPA in support of the Part 503 regulations (Appendix E). No data are available that can be used to relate any type of biosolids-related exposure to any occupational or consumer-related exposure to chemicals that could be meaningfully interpreted. Further investigation would require an expenditure and work effort that are not warranted by the low risk reported by the EPA.

## Routes and Pathways of Contact

### Introduction

There are numerous pathways by which humans can come into contact with biosolids or biosolids-derived contaminants. These include direct contact or accidental ingestion, inhalation of biosolids-derived aerosols or dust, ingestion of water (surface waters and groundwater), and consumption of crops grown in biosolids-amended soils or of animals that have fed on crops grown in such soils. In addition, a variety of vectors can transmit pathogens (flies, mosquitos, fleas, rodents, or other animals than can transport the disease either mechanically or by biological processes) from biosolids to humans or intermediate hosts (Eastern Research Group 1992).

These various routes or pathways of contact can result in either acute or chronic disease if the exposure (dose) is high enough. For pathogens, the primary concern is acute diseases of a short-term duration (i.e., gastroenteritis or flu-like symptoms), while for the various potential chemical contaminants, risks are derived from chronic exposure via ingestion.

Pathogens that may be present in biosolids applied to land pose a disease risk only if there are routes of exposure that deliver an infective dose. The principal means of exposure is through ingestion or inhalation. Absorption through the skin is considered to be a minor route of exposure unless a field worker suffers a cut or other puncture to the skin and is exposed.

The EPA Part 503 regulations, which form a minimum set of standards for the regulation of biosolids in the GO, were developed after years of evaluation using various risk assessment methodologies (U.S. Environmental Protection Agency 1993). These methodologies focus on the various potential pollutants and the pathways that they might use to enter the human and animal diet. Risk assessments were not performed for the various pathogens, but risk management policies developed as part of the regulations assumed the use of technology and management practices to control pathogens (U.S. Environmental Protection Agency 1989a, 1989b, 1992c).

The scientific literature reviewed for this evaluation includes many general reviews and assessments of the environmental risks associated with various pathogens that may be present in biosolids (Feachem et al. 1978; Fitzgerald 1979; Little 1980; Clark et al. 1981; Kowal 1982, 1985; Sorber and Moore 1987; Scarpino et al. 1988; Dawson et al. 1982; and U.S. Environmental Protection Agency 1985b). Other risk assessments looked at bacterial and viral pathogens and how they might affect drinking water (Russin et al. 1997, Haas et al. 1993); in addition, Teunis and Havelaar (1996) assessed the risks for parasitic protozoans in drinking water. Adenovirus in wastewater was the subject of a risk assessment in 1997 (Crabtree et al. 1997) and rotaviruses and their risks were addressed in 1996 (Gerba et al. 1996).

Many other studies have been conducted to characterize the levels of chemical compounds found in biosolids (Kowal 1985; U.S. Environmental Protection Agency 1985b, 1990, 1992b) and the risks they might pose to human health using a deterministic point estimate approach to risk assessment. This approach looks at single values for input variables versus a range of input values (probabilistic approach using a Monte Carlo simulation), which some argue is needed (Harrison et al. 1999). Risk estimates based on ingestion of foods grown on biosolids-amended soils or consumption of meat from animals fed crops grown on biosolids-amended soils is an extremely challenging endeavor, given the wide range of variables that go into any risk assessment.

## Direct Contact

The greatest direct exposure to biosolids is experienced by wastewater treatment plant operators and biosolids management facilities operating personnel. The greatest possible health risk associated with direct contact would probably involve a person having a cut or an exposed wound coming in direct contact with biosolids or contaminated operating equipment as the result of an unusual incident such as a fall or accident. Studies of the incidence of disease among wastewater personnel have indicated that they have no greater incidence of disease than the population in general (Clark et al. 1980, Cooper 1991). Farmers who have worked biosolids-amended soils have direct contact with biosolids and can get biosolids on their clothing. Studies have also been performed to compare the health of farm families from those farms using biosolids with the health of families on farms not using biosolids, and no health differences have been found (Dorn et al. 1985).

## Pathogen Transport to Plants and Animals

When biosolids are applied to the land, pathogens that may be present in the biosolids can be deposited on plants, either directly from application operations or indirectly by vectors.

Virus transport from soil to plants has been suggested as a possible route of exposure, but no definitive research has shown this to occur (Straub et al.1993). Planting restrictions are applied on biosolids-amended fields to ensure that contamination of plants is minimized until die-off of any residual pathogens have occurred and risks are reduced. Animals could be harmed by biosolids-derived pathogens if they were exposed to a high density of pathogens. Typically, domestic animals are not present on the sites where biosolids are applied and the sites contain little wildlife because of the farming activity or other agricultural activities that occur make the environment less attractive as habitat. Grazing animals could be exposed to pathogens, but restrictions are normally placed on such activities to allow time for pathogens to reach very low densities by die-off.

Potential bacterial and viral pathogens carried by animals that could be contracted by humans include tuberculosis, salmonella, lysteria, campylobacter, rotovirus, and toxoplasmosis. More than 50 animals can carry *Cryptosporidium.* Rats and mice in particular are vectors for serious illnesses—for example, rodents may drink treated wastewater containing *Salmonella* from a local waterway, and the *Salmonella* could be transferred to chickens that eat rodent droppings incidentally, which then transfer the pathogen to humans through eggs (Kinde et al. 1996).

## Transport on Crops, Equipment, or Clothing

Inanimate objects (such as crops, soil, equipment, and the shoes or clothing of workers) may be contaminated with infectious organisms that can be transported from sites of biosolids application. Restricting the harvesting of crops until natural die-off of remaining pathogens occurs, combined with good ~~sanitary~~sanitation practices and management practices for on-farm workers and biosolids transporters, has played a key role in minimizing the transport of pathogens offsite.

## Vectors

Vectors are agents capable of transmitting a pathogen from one organism to another. Vectors can achieve this mechanically (simple transport by animals or insects such as flies) or biologically by playing a role in the life cycle of the pathogen (rodents). The traditional vectors are insects, particularly flies, but other vectors can include farm workers or biosolids workers who become ill and infect their families. Grazing animals can also be vectors. Parasite eggs from domestic animals have been demonstrated to have the ability to be transported by flies to grazing land and infecting livestock (Eastern Research Group 1992). Control of vectors has been an important element in the development of the Part 503 regulations (U.S. Environmental Protection Agency 1995, Eastern Research Group 1992), which include treatment and management practices that

prevent conditions that attract vectors. Worker protection, good sanitation, and documentation of medical histories and sickness in workers' families can play an important role in preventing disease transmission should it occur.

## Air Transport

Aerial dispersion of bacterial diseases such as tuberculosis, listeriosis, and legionnaires' disease have been documented (Szabo et al. 1982, al-Ghazali and al-Azawi 1988, Bigness 1999, and Rusin et al. 1997). Monitoring studies are limited, but studies indicate there is less risk associated with biosolids land application (unless it is a liquid spray operation) than with spray irrigation of wastewater which has not been disinfected. Studies of wastewater aerosol formation over a period of years showed little impact on air quality (Pahren and Jakubowski 1980). Studies in Texas showed that bacterial levels were highest around the sludge mixing and loading facilities where agitation occurred and showed that normal heterotrophic bacteria were present in air, but there was an absence of Salmonella, fecal coliforms or coliphages (Pillai et al. 1996) Pathogenic *Clostridia* were detected where physical agitation occurred. These researchers recommended wearing masks to minimize risk to operators. Monitoring of coliphage and enteroviruses in sewage and air adjacent to an activated sludge plant showed that coliphages were not necessarily a good indicator of enteroviruses (Carducci et al. 1995). This points out the difficulties in finding suitable indicators for environmental monitoring.

Dust and fine particles that can be inhaled and reach the deepest parts of the lung are of particular health concern. These fine particles (referred to as PM10) have been regulated for at least ten years with both federal and state standards (See Chapter 10). Also regulated are air toxics at both the federal and state level.

Measurements of bacteria in the air downwind of biosolids processing or application sites is limited (Pillai et al. 1996) and the data collected shows the presence of high numbers of bacteria when there is mixing or dispersal (like a manure spreader), but the risk of an infectious dose of a pathogenic bacterial species in an outdoor area appears to be negligible (Pillai et al. 1996). No reported cases of bacterial or viral illness derived from such an occurrence were found during the literature review including the work of Pillai et al. (1996).

There have only been a few reported cases of biosolids-related illnesses as a result of airborne transmittal of pathogens (see aspergillus discussions in this chapter). Nethercott (1981) reported illnesses from sludge incinerator dust, but this pathway is not applicable to this project. Most of these incidences are related to work in confined spaces such as sludge dewatering facilities, composting facilities (Clark et al. 1983, Millner et al. 1980),

or processing facilities and not related to the transport, unloading or application of biosolids.

There have been reported cases of fungal allergies and possible outbreaks of asthma near composting operations that have generated large populations of *Aspergillus fungi* which thrive in the environment created during composting (Kramer 1992). Studies of composting operations and at farms where biosolids have been used show no unusual health effects compared to farms where no biosolids were applied (Dorn et al. 1985). These fungi are found everywhere where the right conditions exist (compost piles, wood chip piles, potted plants), not just in biosolids operations (Raper and Fenel 1965).

Those at risk in the areas immediately adjacent to such operations are immunosuppressed people such as organ transplant recipients, and people with cancer, AIDS, or leukemia (Rosenberg and Minimato 1996, Ampel 1996). Such operations have been regulated such that setbacks and restrictions on dust generation have been placed on them by the California Integrated Waste Management Board.

Transport of bacteria, viruses and other pathogens by air or by aerial vectors such as insects and birds has been hypothesized.

No reported cases of air-borne transmission of disease have been documented in California as it relates to biosolids management although the potential exists.

## Groundwater Transport

When biosolids are applied to the land surface, the particulates in biosolids typically combine with soil material to form a filter mat so that primarily, soluble and colloidal particles enter the soil. Larger organisms such as protozoans and helminth eggs are retained in the upper soil layers, while virus particles and small bacteria can be transported through the soil to groundwater. As discussed in Chapter 3 and Chapter 4, the mechanisms of pathogen removal in soil are primarily filtration (affects bacteria) and adsorption (for viruses).

Coarse sands and soils with gravel lenses are those most conducive to pathogen transport to groundwater (Kowal 1985, Woessner et al. 1998). Most other soils, particularly fine-grained soils, are effective at removing both bacteria and viruses. The most important consideration after the soil type is the depth to groundwater and proximity to wells used for water supplies, particularly those serving as drinking water which is not subject to treatment and disinfection after it is extracted. The separation between water supply sources and wastewater management facilities using setbacks has been an effective means of protecting public health and relying on the natural filtering qualities of soils.

As described in Chapters 3 and 4, the study of the movement and transport of bacteria and viruses in soils and the transport to groundwater has been the subject of many studies. Most often these studies have focused on viral transport (or coliphage, viruses that are in bacteria) from wastewater and use tracers to simulate viruses due to the difficulty in obtaining permits to actually release viruses into the environment (McKay and Cherry 1993). The difficulty in such studies is the low concentrations that must be detected. Large amounts of water must be filtered to obtain a measurable amount of viruses in groundwater. Generally, this means that it would be extremely hard to obtain an infectious dose due to the large amounts of water that would have to be consumed. Studies on the transport of most viruses at biosolids land application sites has shown that adsorption and/or filtration have reduced viral density and prevented it from reaching groundwater (Straub et al. 1994). However, further research is needed due to the variety of viruses, differing soil conditions, and different climatic regimes. A typical maximum survival time for viruses in soil (at very low temperatures) is 170 days (Kowal 1985) (see Table 5-2) and the maximum distances traveled, even in sandy soils the is about 2 feet per day when a site is under intense recharge (Gerba et al. 1991). Only in instances where there has been significant contamination under unusual circumstances (fractured rock or very porous soils allowing wastewater from a septic tank to reach a drinking water well for example, such as occurred in an outbreak of gastroenteritis in 1991 [Lawson et al. 1991]) is it likely that viruses can pass through most soils to reach potable groundwater (Woessner et al. 1998). Setback and minimum distances between wastewater disposal or biosolids disposal operations and potable wells have been used to provide for safe management of human wastes. There have been no instances in the literature reviewed where biosolids land application has resulted in the measurable contamination of groundwater with pathogens that have contributed to an outbreak of disease.

## Surface Water Transport

As discussed in Chapter 3, biosolids application has the potential to contribute to surface runoff and transport potential contaminants to local surface waters. Washoff into surface waters used for irrigation, stockwatering, potable supplies or recreation are all possible modes of exposure under extreme conditions, such as flooding during a high-intensity storm. The potential pathogens and diseases they cause have been discussed. Survival in surface water of various pathogenic microorganisms was presented in Tables 5-1 through 5-4 and indicate relatively short survival times compared to survival in groundwater. Risk assessments of virus in drinking water (Haas et al. 1993) and water (Crabtree et al. 1997 and Gerba et al. 1996) and other microbial risk assessment models (Teunis and Havelaar 1996, EOA 1995) have been evolving and refined to better estimate risks associated with various pathogens. Most of these efforts to conduct risk assessments have been limited to use with water because of the higher degrees of

exposure that people have to water and the simple fact that there are disease outbreaks attributable to waterborne pathogens. No such outbreaks have been recorded for biosolids, so little attention has gone into the development of models for pathogen risk in recent years. Proper site management can preclude washoff of pathogens and particulates.

## Potential Health Effects from Direct Ingestion or Intake ~~via~~of Foods Related to Biosolids

Health effects from contaminants that may be present in biosolids and have been found to be of human health concern (and thus have regulatory limits based on human health concerns) due to ingestion of foods grown in biosolids-amended soils or from direct ingestion (children less than 2 years of age) of biosolids are summarized in Table 5-9. Most of these health effects are uncommon and most have been noted in the literature when there is some form of severe contamination of food supplies by hazardous wastes, toxic chemicals, or industrial contamination from chronic discharges prior to implementation of pollution control regulations. All of these contaminants and many others have been addressed or are being addressed in on-going regulatory control programs to update or develop new standards for protecting public health. Development of the 503 regulations involved an extensive review of individual pollutants and the use of hazard indices and assessment of worst case exposure conditions to develop numerical limits for biosolids that would assure protection of public health under proper management conditions (U.S. Environmental Protection Agency 1985). Such standards include those related to drinking water, surface water, groundwater, food safety, fertilizer quality, consumer products, air quality, and biosolids through the 503 regulations development.

The health risks from biosolids land application were found to be the highest for a child directly ingesting biosolids for several of the trace metals (Pathway 3 for arsenic, cadmium, lead, mercury, and selenium) (see Appendix E, Part 2). For other regulated compounds, phytotoxicity was found to be the limiting pathway (chromium, copper, nickel and zinc). Molybdenum was limiting due to animal health concerns from consuming biosolids-amended feed. The reduction in risks to humans occurs as a result of the soil-plant barrier concept (described by Chaney 1980) which shows that if plants and/or animals are protected against toxicity from biosolids-applied metals (through natural processes), then humans are protected (plant phytoxicity would occur and thus it would not grow and be consumed or there would be less consumption because of reduced plant yield). For some conditions, risks from excessive selenium, molydenum and cadmium would not be prevented through this mechanism. However, antagonistic effects from zinc, calcium and iron present in biosolids and the soil may counteract toxic effects by acting to inhibit absorption in animals (U.S. Environmental Protection Agency 1995a).

## Table 5-9.
## Chronic Human Health Effects Associated with Regulated Contaminants Found in Biosolids

| Contaminant | Health Effects | Exposure | Environmental Fate |
|---|---|---|---|
| Lead | Permanent neurological damage; endocrine system disruption | Mainly from fruits and grains, deposition from air to plants, livestock, children ingesting soil or biosolids | No known safe level persistent |
| Cadmium | Cancer, kidney disease, neurological disfunction, fertility problems; immune system changes; birth | Defects mainly through food, children ingesting soil or biosolids | Persistent, bioaccumulative |
| Dioxins | Cancer, endocrine disruption, immune system damage; negative effects seen at levels as low as ppt | Mainly through meat and dairy consumption | Persistent, bioaccumulative |
| Mercury | Neurological disfunction | Mainly through fish and food consumption | Persistent, bioaccumulative |
| Selenium | Toxicity in humans is rare, most effects in grazing animals | Children ingesting biosolids | Persistent, bioaccumulative |
| Arsenic | Malaise, fatique, gastrointestinal disturbances; peripheral neuropathy | Children ingesting soil or biosolids | Persistent, bioaccumulative |
| Salts (sodium) | Chronic effects such as carbiovascular | Water supplies, excessive intake in foods | Persistent |
| Nitrate | Methemoglobanemia | Contaminated groundwater | Persistent |
| Organics | Acute toxicity; hypersensitivity mutagenesis; carcinogenesis; other chronic effects[a] | Children ingesting soil or biosolids, consumption of contaminated food and water supplies, breathing air in confined biosolids processing areas | Persistent, bioaccumulative |
| Endocrine disruptors[c] | Breast cancer? teratogeneis?[b] | Contaminated food | Persistent |

_____

[a] Chronic effects could include those that are cardiovascular, immunological, hematological, neurological, etc.
[b] Alleged, not demonstrated.
[C] See listings and discussion in Appendix PE (Part 3) for more information.

Sources: Information from Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, and U.S. Environmental Protection Agency accessed on Centers for Disease Control Web page (Centers for Disease Control 1999).

The National Research Council also completed an independent study for the EPA that was released in July of 2002. Although this study recommend further research on the topic, it also stated that there is no documented scientific evidence that land application of biosolids pose any human health risk. This study reviewed the risk-assessment methods and data used to establish concentration limits for chemical pollutants in biosolids, reviewed the current standards for pathogen elimination in biosolids and, explored whether pathogen risk assessment can be integrated with chemical risk assessment (National Resources Council 2002).

There is increasing attention being given to the endocrine disruptors as discussed above under water and further in Part 3 of Appendix E. There are a number of chemicals used in agriculture (pesticides) and compounds which may be present in biosolids which are listed as suspected endocrine disruptors which are widespread in the environment. Actual effects on health from environmental levels of these compounds is still an area of controversy and direct links have yet to be established between chemicals and human health effects.

## Regulatory Setting

The basic standards for the protection of public health from the land application of biosolids are the EPA's regulations adopted in February 1993 which are contained in 40 CFR 503 commonly referred to as the 503 regulations. These regulations establish ceiling concentrations for metals and pathogen and vector attraction reduction standards; management criteria for the protection of water quality and public health; and annual and cumulative discharge limitations of persistent pollutants, such as heavy metals, to land for the protection of livestock, crop, and human health and water quality protection. These criteria are based on a risk-based evaluation using 14 different pathways of potential exposure for humans and animals (see Appendix E, Part 2 for identification of the various pathways and the criteria used). The 503 regulations form the basic minimum standards contained in the GO being addressed by this EIR.

In addition, there are numerous Federal and State laws and regulations which apply to various aspects of the transport and distribution of biosolids for land application and govern all aspects of the operations involved in land application. A general discussion of key regulations governing the protection of public health is presented below. Details can be found in the various statutes. All of these laws and regulations are enforceable by various local, state and federal agencies charged with administering them.

## Waste Discharge Requirements

See "State Programs—Role of RWQCBs" in Chapter 2, "Program Description", for a discussion of WDRs.

## National Pollutant Discharge Elimination System Permits

All wastewater agencies that discharge effluent to the surface waters of the United States are issued NPDES permits by one of the RWQCBs under a program approved by the EPA and delegated to the State of California under provisions of the federal Clean Water Act.

Each NPDES permit contains a monitoring and reporting program that identifies the volume of solid material removed from the wastewater and the locations where this material was taken, including biosolids. The NPDES permit also requires periodic sampling of biosolids for priority pollutants and other constituents of concern in accordance with the provisions of the EPA Part 503 regulations.

## California Hazardous Waste Control Law

In accordance with the California Hazardous Waste Control Law (HWCL), the California Department of Toxic Substances Control (DTSC) is responsible for determining whether sewage sludge/biosolids are a hazardous or nonhazardous material according to CCR Title 22, Article 11. Title 22 defines "sludge" as "any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater plant . . . exclusive of treated effluent from a wastewater treatment plant".

The DTSC uses various adopted criteria to determine whether a sludge is classified as a hazardous waste; these include testing for toxicity, persistent and bioaccumulative toxic substances, ignitability, reactivity, and corrosivity. Any waste that contains a substance that exceeds either a listed soluble threshold limit concentration (STLC) or a listed threshold limit concentration (TLC) is deemed a hazardous waste. Most municipal biosolids are classified as nonhazardous. Determining whether a particular biosolids product is hazardous is a key step in identifying available disposal and reuse options. If a sludge or biosolids product is hazardous, then the GO would preclude its application to

land and may require the issuance of a Hazardous Waste Facilities Permit by the DTSC for certain operations.

## Discharge of Waste to Land

The SWRCB administers CCR Title 23~~, Division 3, Chapter 15~~ and CCR Title 27 (Discharges of Waste to Land), which govern~~s~~ the disposal of wastes in a landfill or on dedicated land disposal sites. ~~Chapter 15~~ These regulations require~~s~~ that all wastes be classified to determine the appropriate type of waste management strategy to be used. As mentioned above, classification of materials as hazardous or nonhazardous is the responsibility of the DTSC. However, the SWRCB and its nine RWQCBs may further classify DTSC nonhazardous waste, such as wastewater sludge, as a designated waste. The solids content of nonhazardous sewage sludge determines the type of landfill that can be used for disposal. The ~~Chapter 15~~Title 27 regulations also address the use of dried sewage sludge as daily landfill cover. RWQCBs play a role in issuing WDRs or waivers for land application sites, inspecting and monitoring such sites, and providing enforcement, as necessary. Any sewage sludge or biosolids that are not suitable for land application under the provisions of the GO and, hence, earmarked for disposal would be subject to provisions of ~~Chapter 15~~Title 27 or further treatment, which could trigger additional requirements, such as compliance with regulations for composting operations.

## Regulatory Requirements for Composting Operations

The IWMB administers solid waste regulations set forth in CCR Title 14 that pertain to composting operations and facilities. Title 14, Chapter 3.1, Composting Operations Regulatory Requirements, apply when biosolids are mixed with chipped green waste for composting. These regulations specify permitting, siting and design, operating standards, sampling requirements, metal concentrations, and pathogen reduction standards. IWMB regulations are implemented through its local enforcement agencies (LEAs), which issue solid waste facilities permits (SWFPs) for composting and dedicated disposal sites.

## Source Reduction and Recycling

IWMB staff members oversee source reduction and recycling efforts of jurisdictions throughout California in accordance with Public Resources Code Section 40000 et seq.~~; which implements Assembly Bill 939 (AB 939) legislation.~~ Under Section 41750, cities and counties were required to begin planning to achieve solid waste reduction immediately to manage remaining landfill space in an effective and environmentally sound manner. Section 40191 defines "solid wastes" as "all putrescible and non-putrescible solid, semisolid, and liquid wastes excluding hazardous waste". Solid wastes by this definition include dewatered, treated, or chemically fixed sewage sludge.

~~AB 939~~Starting with Section 41000, the CCR mandates the use of source reduction, source separation, diversion, recycling, reuse, composting, and co-composting of solid waste to the maximum extent feasible to conserve water, energy, and other natural resources and to protect the environment. ~~AB 939~~Section 41780.2 require~~d~~s jurisdictions to divert 25% of their generated waste by 1995, increasing to 50% by the year 2000. For many jurisdictions in California, land application of biosolids serves as a means of achieving these diversion rates.

## Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5)

Perhaps the most important long-term regulatory standards that govern biosolids are the Safe Drinking Water standards that apply to both surface and groundwaters which are used for public water supplies. Groundwater quality protection is one of the key areas of concern and the GO contains a prohibition against causing these standards to be exceeded as a result of biosolids land application.

## Ambient Water Quality Criteria for the Protection of Human Health

For information on ambient water quality criteria, see Chapter 3, "Soils Hydrology, and Water Quality".

## Ambient Air Quality and Air Toxics

There are no state policies or regulations that specifically address air quality issues related to biosolids land application. There are numerous state and local air quality regulations that govern compliance with transportation-related source emissions (from hauling equipment and incorporation equipment) and general provisions related to compliance with local air quality management district regulations for ambient air quality and specific source control which might have been adopted with regard to toxic air emissions. The federal and state ambient air quality standards of greatest concern with respect to land application of biosolids are the particulate matter standard for fine particulates (PM10). For more details see the air quality chapter (Chapter 10).

## State Health and Safety Code and California Food and Agricultural Code

The California State Codes (Health and Safety, Title 22) and California Food and Agricultural Code contain numerous provisions related to public health and safety which would apply to farming operations that land apply biosolids. These provisions relate to water supply protection, sanitation, sewerage, and general sanitation and crop harvesting as well as pesticide residues and handling of toxic materials. All of these provisions are in addition to all the requirements contained in the GO related to protecting water quality.

Biosolids may contain toxic pollutants (heavy metals, organics, and inorganic compounds) and other chemicals (such as minerals and nutrients) which may be subject to regulation under one or more State laws or regulations governing hazardous materials (if concentrations were high enough). Biosolids that meet the 503 requirements are not subject to hazardous waste regulations because the maximum concentration levels (ceiling levels) are below the levels that would result in the material being classified as a hazardous waste. Section 14505 of the California Food and Agricultural Code classifies soil amendments derived from municipal sewage sludge as fertilizing material which is exempt from hazardous waste regulations. New studies are underway to assess the health hazards associated with different materials used in the manufacture of soil amendments that will further restrict and perhaps set numerical standards for fertilizers.

## ~~OSHA/CalOSHA~~California Occupational Safety and Health Act Requirements

Worker safety is governed by the provisions of the California Occupational Safety and Health Act. These regulations govern workplace safety and health hazards for such things as exposure to hazardous chemicals and substances, excessive noise, and unsafe work conditions. These provisions apply to employers and are designed to provide a safe and healthy work environment.

## Food Safety

The California Department of Food and Agriculture (CDFA) has started an open, facilitated process to develop regulations covering heavy metals in commercial fertilizers, biosolids, non-hazardous ash, and other soil amendments. This work is being done in conjunction with the University of California and will focus on both inorganic and organic fertilizers. The process will continue over the next year. The results of this effort will be reviewed by the SWRCB and adjustments in the proposed GO could be made if necessary to protect food safety.

There are numerous food safety and quality laws which apply to the quality and handling of foods which will apply to the growers using biosolids as a soil amendment. These are not part of the GO which addressed only water quality protection. These regulations include but are not limited to the following:

- Organic Foods Production Act of 1990
- Federal Food, Drug and Cosmetic Act (21 U. S. C. 301)
- ~~Sanitary~~Sanitation Food Transportation Act of 1990 (governs transportation of food products)
- California Uniform Retail Food Facilities Law (CURFFL; Health and Safety Code Sections 27500 et seq.)
- Inspection and certification of fresh fruits, vegetables and other processed foods (7 CFR 51-75P)
- Containers and their inspection (7 CFR 42)

- Food Processing (21 CFR 100-199)
- Labeling, standards of quality and contaminants (21 CFR 109)
- Good Manufacturing Standards (21 CFR 110)
- Enforcement policies (21 CFR 7)
- Production process and use of additives (21 CFR 184-186)
- Prohibited substances (21 CFR 186-189)

, California Health and Safety Code, Division 105, Part 5 (Sherman Food, Drug, and Cosmetic Law)

Note that uncooked food sold by retail establishments and food consumed at home by the public is not directly protected by the Model Food Code, which incorporates the latest and best scientifically based advice for preventing foodborne illness. This Code is used by local and state agencies responsible for inspecting and enforcing safe food handling practices at the retail level.

Also, it should be noted that neither the USDA nor the FDA have specific regulations for the use of biosolids in food production, but rely on existing regulatory programs involved with the consumption of animal products and foods that are commercially processed (general health and safety laws governing water and food sanitation) (National Academy of Sciences 1996).

## Impacts and Mitigation Measures

The following public health impact analysis focuses on the potential for human contact with the pathogens and contaminants known to occur regularly in biosolids in the United States. The number of known foodborne and waterborne pathogens appears to be on the increase as new techniques are developed to detect previously unknown species. No information exists at this time indicating that any of the emerging pathogens pose any greater risk to the public than those that were considered during development of the Part 503 regulations and establishment of mandatory management practices to control pathogens and vectors. Furthermore, there is no indication that there is any more risk associated with biosolids than with other sources of these pathogens. To date, outbreaks of diseases have been associated with undercooked food, fecal-oral transmission, poor food handling practices and sanitation, and inadequate sewage facilities or water

management at specific properties. Biosolids are generated under controlled and monitored conditions in a highly regulated environment.

Some pathogen-related issues will have to be addressed on an ongoing basis as more is learned about the presence and fate of disease-causing organisms referred to as "emerging pathogens", which are newly discovered or have new characteristics that make them of greater concern (e.g., antibiotic-resistant strains). Also of concern are possible effects on immunocompromised populations (particularly people with acquired immunodeficiency syndrome), which might have the potential for increased exposure, under certain unusual circumstances, to pathogens such as *Giardia* and *Cryptosporidium* that may be present in contaminated surface water supplies. Research on methods of detecting the pathogens responsible for emerging diseases and systems of reporting unusual outbreaks (Centers for Disease Control 1999) will have to be relied upon to guide health and regulatory officials toward appropriate regulations and preventive measures to keep disease outbreaks from occurring. Efforts are continuing for better ways to detect the presence of pathogens in wastewater, sludge, and biosolids (Water Environment Federation 1999). To date, no significant outbreaks of infectious disease have been associated with biosolids land application practices (Bastian, Starr pers. comms.).

## Approach and Methods

The public health impact analysis presented below has been coordinated with other technical analyses (those for water quality, air quality, and land productivity) to determine the likelihood of the presence of pathogens or other constituents of concern in land-applied biosolids and the potential for their transport to human receptors. It was assumed for this assessment that any biosolids to be land applied or used for other purposes allowed under the GO would meet the minimum requirements of the EPA Part 503 regulations and the additional restrictions contained in the GO.

Impacts on public health that could result from land application of biosolids are difficult to quantify because of the difficulty of establishing a clear relationship between human exposure to pathogens or chemical contaminants and reported illness in humans. EPA undertook extensive efforts to evaluate potential disease risks associated with biosolids disposal and reuse practices in support of the development of the Part 503 regulations. The numerical limitations and management practices (for pathogens) specified in the Part 503 regulations were derived as a result of extensive scientific studies, reviews of scientific literature, collection of nationwide data on biosolids quality and experiences related to biosolids reuse, epidemiological studies, detailed risk assessments for each of the regulated constituents and many others (some 200 chemicals initially), and field

studies to quantify the concentrations and environmental fate of pathogens and chemical contaminants in biosolids.

This assessment relies on all those studies and the EPA Technical Support Documents prepared for the Part 503 regulatory program. EPA's information was used to establish a baseline for identifying impacts in this analysis and to determine relative risks to individuals from biosolids reuse practices. Additional research was conducted to identify conditions specific to California, including disease incidence and physical (soil and hydrologic) conditions not anticipated in the Part 503 regulations. The analysis also assumes "worst-case" conditions, such as the use of Class B biosolids (with a higher allowable pathogenic microorganism content) and the maximum allowable application and cumulative loading rate (up to the limits allowed in the 503 regulations and GO).

Conclusions regarding the potential for impacts were drawn based on best professional judgment, given the available information and assuming worst-case conditions. The quantitative risk assessments performed by EPA (U.S. Environmental Protection Agency 1995) and others (Scarpino et al. 1988, Rusin et al. 1997, ABT Associates 1993), combined with reviews of the literature used to support the development of the Part 503 regulations, new scientific literature published or made available since 1995, and personal contacts with experts and officials around the state and elsewhere, were used in support of this impact assessment. The significance of potential impacts was evaluated based on the available data on the potential extent, duration, frequency, and intensity of effects.

The evaluation of impacts is supported by the information provided above under "Environmental Setting" and in Appendix E, which is referenced as necessary to support the environmental determinations.

## Thresholds of Significance

According to thresholds established by existing public health regulations (federal, state, and county), a project may result in a significant impact if it would:

- create a public health hazard or involve the use, production, or disposal of materials that pose a hazard to people or to animal or plant populations in the area affected;

- violate federal, state, or local criteria concerning exposure to biosolids-derived contaminants or pathogenic microorganisms (including the Safe Drinking Water Act, federal Occupational Safety and Health Administration workplace standards, food safety laws, and other public health criteria); or

- **g** violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations.

## Impacts of Agricultural Use

### Impact: Potential for Increased Incidence of Disease Resulting from Direct Contact with Pathogenic Organisms at Biosolids Land Application Sites

Under the GO, land application of biosolids could increase from 456,040 dry tons per year in 1998 to 576,690 dry tons per year in 2015 as the state's population increases and levels of wastewater treatment are improved. The amount of land on which biosolids are beneficially used is likely to increase, resulting in an increased probability of humans coming in direct contact with biosolids. Although it has been demonstrated over the years that anaerobic digestion is effective at reducing bacterial hazards associated with biosolids, concerns still exist over the survival of viruses or pathogens that encyst (such as *Cryptosporidium*, or *Ascaris* ova) and that could be transmitted to humans through direct contact.

Those people with the greatest potential for direct exposure to biosolids are equipment operators at wastewater treatment plants and land application sites, and farmworkers. Individuals in these categories could also cause incidental exposure of their families to biosolids if they carry biosolids home on their shoes and clothing. Risks to the general public also could increase as a result of increased exposure if land application activities occur at sites accessible to the general public.

The issue of the survival in biosolids of viruses or pathogens that encyst and their potential transmission to humans was reviewed by a panel of experts convened by the National Research Council and discussed in its report "Use of Reclaimed Water and Sludge in Food Crop Production" (National Academy of Sciences 1996). The panel noted, "There have been no reported outbreaks of infectious disease associated with a population's exposure—either directly or through food consumption pathways—to adequately treated and properly distributed reclaimed water or sludge applied to agricultural land." The report also noted that because there are many sources of infectious disease agents other than reclaimed water or biosolids used in land application, such as prepared food and person-to-person contact, the potential added exposure to pathogens resulting from the proper recycling of these materials is "minuscule compared to our everyday exposure to pathogens from other sources".

The issue of microbiological risks from contact with biosolids remains controversial, however, in part because epidemiologic evidence is very difficult to compile and any

association between health problems and biosolids application (or other environmental exposure) is extremely difficult to document. Considering the concentrations of long-lived encapsulated forms of certain pathogens (such as *Giardia*, *Crytosporidium*, and *Ascaris*) that have been found in biosolids, it may be assumed that some risk to farmworkers and others working closely with biosolids will always exist. An infectious dose could be as low as one ovum for *Ascaris* and, although their viability remains in question, ova are found at concentrations in digested sludge of 2-10 per gram of dried biosolids. One would have to ingest only a small quantity of biosolids to get such a dose; however, the low probability of adult ingestion of biosolids must be taken into consideration as well.

The available data on workers exposed to biosolids do not support a conclusion that direct exposure to biosolids increases health risks. Wastewater treatment plant personnel, the workers having the greatest occupational exposure to biosolids, have been found to have no greater illness rates than the general public (Clark et al. 1983). To date, compost workers are the occupational group for whom the most evidence of potential effects from biosolids handling has been found; however, these workers, working within 100 meters of composting operations, were found to experience only minor effects (Jakubowski 1985). Furthermore, the observed effects may have been the result of irritants produced in the composting process (dust, *Aspergillus*) and related to wood chips rather than the sludge portion of the compost (see discussions under "Environmental Setting" above and in Appendix E for more details).

Incidental human contact and farmworker and family contact with biosolids were evaluated in an extensive study reported by Dorn et al. (1985). The 3-year study covered three geographical areas in Ohio and included 47 farms (164 persons in 78 families were evaluated) receiving annual applications of treated sludge (average of 2–10 dry metric tons/hectare/year; average of 3.6 to 17.8 wet tons per acre per year at 25% solids). (Dorn et al. 1985). The illness rates in the families at their farms were compared with 46 control farms (130 persons from 53 families), all of whom initially participated by cooperating with monthly questionnaires concerning their health and their animals' health, annual tuberculin testing, and quarterly blood sampling for serological testing. It should be noted that the number of participating farms dropped as the study went on, and only 27% of the 93 original farms completed participation in the 3-year study.

A summary of the two study groups and their numbers over the years is shown below:

| | | | Number Participating | | |
|---|---|---|---|---|---|
| Unit | Study Group | Number Started | 1 Year | 2 Years | 3 Years |

| | Study Unit | Number Started | Number Participating | | |
|---|---|---|---|---|---|
| Farms | Sludge | 47 | 47 | 36 | 13 |
| | control | 46 | 46 | 37 | 13 |
| Participants | Sludge | 165 | 165 | 126 | 53 |
| | control | 130 | 130 | 109 | 37 |

Source: Comment letter 43, page 17 as cited from Dorn et al. 1985.

The study found that the estimated risks of respiratory illness, digestive illness, or general symptoms were not significantly different between the sludge farm and the control farm residents (Dorn et al. 1985). It also found no observed differences between disease occurrence in domestic animals on sludge and on control farms. The frequency of serological conversions (fourfold or greater rise in antibodies) to a series of 23 test viruses and the frequency of associated illnesses were similar between the persons on sludge and on control farms. The absence of observed human or animal health effects resulting from sludge application in this study of Ohio farms should be considered with the knowledge that relatively low sludge application rates were used on these farms; the rates were lower than typical application rates for agricultural uses in California (which may be as high as 30-40 wet tons per acre per year). Necropsy data and analyses of tissues found significant cadmium and lead accumulations in the kidneys of calves grazing sludge-treated pastures. The consequences of this are not known in terms of either animal health or human health, assuming humans consume the kidney tissue on a regular basis in animals that bioaccumulate trace metals in their organs.

The authors reported that “the possibility of PCB and other toxic organics reaching crop land is an issue of concern to farmers” and indicated that “more research is needed.” They further noted that “caution should be exercised in using these data to predict health risks associated with sludges containing higher levels of disease agents and with higher sludge application rates and larger acreages treated per farm than used in this study” (Dorn et al. 1985). No similar subsequent studies have been performed because the risks were deemed to be low and the costs for such studies are very high.

In addition, results of the evaluation of reportable disease data for California on the known pathogens that could be present in biosolids (discussed above under “Environmental Setting”) showed that there was no apparent association between disease incidence in the general public and the size and location of biosolids application operations. Those counties where the largest quantities of Class B biosolids are being beneficially reused either have no reported outbreaks or incidence of infectious disease associated with those pathogens that might be derived from direct contact with biosolids

or have very low numbers of such reports or incidences. Discussions with various health and water quality officials revealed no known infectious illness that could be related to biosolids use (Shaw, Moise, and Starr pers. comms.).

Investigations undertaken by researchers from Cornell University's Waste Management Institute and the University of Georgia at Athens reviewed numerous incidents where residents living near biosolids application sites had reported illnesses which they believed were the result of exposure to biosolids. These incidents included two deaths in which Staphylococcus aureas was identified as a cause. While the medical histories of the patients were reviewed, no samples were taken of the fields or biosolids from which the illnesses were alleged to have come. The published results of the studies noted that while the evidence was anecdotal, S. aureas in biosolids should be of concern to regulators as a health risk because of the number of incidents being reported. (Harrison. 2002; Lewis 2002)

However, there is no direct evidence that S. aureas is present in biosolids or that it is the source of the illnesses reported to the Cornell University and University of Georgia researchers. The National Science Foundation Water Quality Center at the University of Arizona undertook to sample unprocessed sewage and Class A and Class B biosolids, including biosolids in aerosol form, for the presence of S. aureas. The results of this study, published in the journal Environmental Science and Technology, found S. aureas in untreated sewage, but no presence of S. aureas in any of the biosolids samples. It concluded that the Class A and Class B treatment processes are effective in neutralizing S. aureas and that this microbe does not pose a risk to public health. (Rusin 2003)

The GO includes provisions requiring signage and setbacks to deter direct human contact with biosolids. There are also strict controls on the movement of biosolids off of the application site. There are no provisions to preclude human contact (such as fencing requirements), however, and some potential for human contact with biosolids will always exist.

Based on a review of the information presented above, no adverse impacts associated with direct human contact with biosolids at land application sites are expected. Thus, the risks of disease resulting from direct contact with biosolids are considered to be less than significant. Furthermore, the GO reinforces existing regulations and permit conditions and is intended to protect public health and the environment. Therefore, implementation of the GO is likely to result in fewer risks associated with direct contact because its monitoring and reporting provisions represent an increased level of regulatory oversight of land application. No mitigation is required.

Existing large land application operations using Class B biosolids are in remote areas away from housing, schools, water reservoirs, dairies, and food crop production areas.

Thus, current exposure of the general public to biosolids is minimal. Signage and setbacks required under provisions of the GO serve to deter direct contact of the general public to biosolids. Therefore, this impact is considered less than significant. Mitigation Measure 5-1 is recommended, however, to further reduce this impact.

**Mitigation Measure 5-1: Review Manual of Good Practices.** Although no significant public health risk is expected from direct human contact with biosolids, it is recommended that all individuals or agencies receiving land application permits under the GO receive a manual of good practices that addresses measures to protect human health. The California Water Environment Association Manual of Good Practice— Agricultural Land Application of Biosolids is an example of such a manual (California Water Environment Association 1998).

### Impact: Potential for Increased Incidence of Disease Resulting from Direct Human Contact with Pathogenic Organisms in Irrigation Runoff from Biosolids Land Application Sites

Surface waters can transport pathogenic microorganisms from various sources and infect humans who might ingest these waters or be exposed to waterborne parasites that enter wounds. Although this is a common mode of disease transmission in areas of the world with poor sanitation, irrigation waters in California have not been implicated in disease outbreaks associated with infectious agents or other contaminants because they are not typically an untreated drinking water source. Furthermore, the proposed project would not result in a significant increase in disease because irrigation runoff from land where biosolids have been applied must be controlled for 30 days following biosolids application. These controls would be effective in avoiding offsite movement of biosolids under all but the most extreme conditions. During such conditions, when low-probability storm events or widespread flooding occurs, the runoff entering waterways is likely to contain pathogens from sources other than biosolids-amended fields, and the incremental contribution from biosolids is expected to be minimal. As under normal conditions, unless there is a high degree of contamination (not expected from biosolids) and there is a mode of entry (cut or accidental ingestion), it is unlikely that an infectious dose can be delivered under such circumstances. Therefore, this impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

### Impact: Potential for Increased Incidence of Disease Resulting from Ingestion of Pathogenic Organisms in Crops Grown on Land Application Sites or Animals Fed with Crops Grown on Land Application Sites

Because an increased amount of biosolids will be applied to land as populations increase, there will be an increase in pathogens of human origin entering the soil. Such pathogens could be transmitted to humans through crops grown on biosolids-amended soils or in foods produced from animals fed on crops grown in these soils.

The GO includes various Class B biosolids site restrictions on the timing of planting and harvesting crops at application sites: no harvesting of food, feed, and fiber crops within 30 days of application; no planting of food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface within 14 months of application; no harvesting of crops with parts below the land surface within 20 months of application unless the biosolids have been exposed to kill pathogens for at least 4 months on the surface of the soil; and no harvesting of crops with parts below the land surface within 38 months after an application where biosolids have not been exposed to kill pathogens for at least 4 months on the soil surface. The GO also includes restrictions that apply to the harvesting of turf grasses and prohibits for 1 year following application of biosolids, the grazing of animals used to produce milk that will be marketed without being pasteurized. These restrictions act as a further buffer against potential contamination after the significant pathogen reductions achieved by biosolids treatment.

No cases of infectious disease related to food or animals being contaminated with pathogenic microorganisms have been noted in the literature reviewed for this analysis, and discussions with health officials indicate that no such cases have been reported (Starr, Shaw, Cook, and Isozaki pers. comms.). The greatest risk is probably from the transmission of helminth ova from biosolids to grazing animals. However, the concentrations of ova found in biosolids are low, and the risks of disease transmission from this source are low. Bacteria and viral diseases will be prevented if growers follow the provisions of the GO. This impact is considered potentially significant because of the survival times of potential pathogens. The following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

**Mitigation Measure 5-2: Extend Grazing Restriction Period to Allow for Pathogen Reduction.** For grazing sites where application of biosolids is proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after application. The proposed GO should also be revised to require that grazing of animals be deferred for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum degradation of pathogens (and SOCs) before grazing animals are exposed to the soil. See also Mitigation Measure 4-2.

### Impact: Potential for Increased Incidence of Chronic Human Disease Resulting from Ingestion of Biosolids-Derived Metals in Crops Grown on

## Land Application Sites or Animals Fed with Crops Grown on Land Application Sites

As populations increase, an increased amount of biosolids will be applied to land, and there will be an increase in loadings of trace metals to biosolids-amended soils. Potentially toxic levels of metals could be transmitted to humans through crops grown on biosolids-amended soils or in foods produced from animals fed on crops grown in these soils without proper control of biosolids application rates.

EPA extensively assessed levels of risk associated with biosolids-derived pollutants of concern (trace metals and PCBs) that might contribute to chronic diseases in the Part 503 risk assessments (U.S. Environmental Protection Agency 1995). The risk assessment used to establish the conservative national numerical limitations for toxic pollutants examined various pathways (see Appendix E) by which contaminants might become present on edible plant parts or bioaccumulated in animals consumed by humans that grazed or were fed crops grown on biosolids-amended soils. These detailed risk assessments relied on many assumptions about types and amounts of food ingested, number of years of exposure, and a host of other factors (U.S. Environmental Protection Agency 1995).

EPA reports conclude that heavy metals and dioxins have been extensively studied and that it has been shown that they do not have the potential to cause significant effects given the rates at which biosolids are applied and used (U.S. Environmental Protection Agency 1992b, 1995). EPA found that overall cancer risk associated with food ingestions would be reduced by implementation of the Part 503 regulations (U.S. Environmental Protection Agency 1995) from 0.9–5 cancer cases annually to 0.09–0.7 annually. This is an extremely small number of cancer cases and represents very low risk.

There are several issues of concern regarding the level of protection provided by the Part 503 regulations with regard to toxic pollutants. The assumptions used in calculating the risk and the level of risk chosen as appropriate for the development of regulatory levels are a continuing source of controversy. One of the greatest concerns is the choice of risk factors ($10^{-4}$ versus $10^{-6}$) for the development of allowable contaminant levels in land-applied biosolids under the 503 regulations. (Harrison et al. 1999.) Many argue that there is no safety factor in the established maximum contaminant levels and that there is not an adequate system to monitor long-term cumulative increases in soil contaminants that could contribute to bioaccumulation in plants and animals and that cumulative impacts could therefore occur over time as soil levels of contaminants build up.

Other issues of concern relate to the bioaccumulation of cadmium in plant tissues consumed by humans; ingestion by children of biosolids-amended soils containing trace

metals and other toxic pollutants, particularly in the home garden setting where Class A biosolids may be used; and rates of dietary intake for various contaminants such as arsenic, synthetic organic compounds, and radioactivity (Harrison et al. 1999). Another area of controversy is the exclusion of certain individual pollutants (i.e., chromium) from the cumulative loading restrictions.

No epidemiological studies are available that evaluate biosolids practices in California and their relationship or contribution to the overall intake of various trace metals. EPA and the California Department of Health Services are evaluating risks associated with environmental exposures to various toxic pollutants in the state.

The analysis in Chapter 4, "Land Productivity", concluded that significant metal-related impacts on agricultural soils and land productivity could occur under the proposed GO program for some combinations of California soils and crops but would probably be rare. However, such impacts are not likely to lead to impacts on public health resulting from consumption of affected crops grown in these soils. The basis for this conclusion, as discussed in the environmental setting above, is the soil-plant barrier (Chaney 1980) (used as a basis for the Part 503 regulations), which is the manifestation of toxicity in plants accompanied by impairment of crop yield and desirability, reducing the chances of contaminated plants being consumed except in extremely unusual circumstances. The most notable exception is where crops are grown on cadmium-contaminated soil over an extended period and a high percentage of a consumer's diet is derived from these crops, as reported to have occurred in Japan over a 40-year period (National Academy of Sciences 1996). As stated in Chapter 3, arsenic, molybdenum, and cadmium in particular can be mobile in non-acidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic to plants in low soil concentrations.

Copper, mercury, and selenium are the only trace metals in the 1998 CASA survey data for biosolids in California that, at maximum reported concentrations, exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation. The GO contains limitations in addition to those in the Part 503 regulations that would limit chromium and molybdenum application to land. None of these compounds is likely to pose a significant risk to health in association with biosolids land application subject to regulation under the GO because of the GO's restrictions on cumulative loadings. Some have argued that biosolids are a source of environmental mercury that can affect local waterways or be volatilized (Harrison et al. 1999). The GO contains provisions that would prohibit biosolids from affecting local waterways. Mercury emissions through volatilization remain a controversial issue, but such emissions pose no threat to public health because mercury is present in biosolids only at low levels (U.S. Environmental Protection Agency 1995).

Because the proposed GO contains the same or more stringent requirements than established under the EPA Part 503 regulations, the project should be protective of public health and pose minimal risk associated with the ingestion of various foods or animal products derived from biosolids-amended soils.

As long as source control programs are effective at keeping metals levels in biosolids below the EPA Part 503 limitations and the provisions of the GO regarding application rates (annual and cumulative or ceiling limits) are enforced, the risk of increased disease resulting from the presence of trace metals should be low and there will be no significant impact on public health. This impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

### Impact: Potential for Increased Risk of Chronic Disease Resulting from Ingestion of Biosolids-Derived Organic Compounds in Food, Soils, Animals, Dairy Products, or Wildlife

A number of SOCs, such as PCBs, pesticides, and detergent-derived organic molecules, are contaminants that may be present in biosolids. As the amount of biosolids applied to land increases, the levels of these compounds may increase in biosolids-amended soils. These contaminants could be transmitted to humans through various pathways. Because many of the compounds in this category have been suggested as being potential carcinogens or endocrine disruptors (see "Environmental Setting" and Appendix E), a potential increase in their levels may be an issue of public health concern.

There are no annual or cumulative loading limits established for SOCs in biosolids because the risks associated with the presence of these compounds in biosolids is considered to be very low. Concentrations of these compounds in biosolids are generally found to be below detection limits or very low; many of the compounds are highly volatile and do not accumulate in soils or plants (see Chapter 4). However, some compounds, particularly chlorinated hydrocarbons—PCBs and plasticizers such as bis (2-ethylhexyl)phthalate and dioxins—are of concern as cumulative contaminants that can undergo bioaccumulation.

The principal routes of exposure to toxic SOCs that may be present in biosolids include uptake by plants and consumption of the plants by humans, direct contact of edible plant parts with biosolids and subsequent consumption, direct contact by children who play in or ingest biosolids, uptake by plants used as animal feed and subsequent human ingestion of meat or animal products, and direct ingestion by grazing animals with subsequent human ingestion of animal products. Direct human ingestion is a remote possibility and is not considered a significant or likely source of disease. One major source of dioxins on the

farm is wood treated with the wood preservative pentachlorophenol, used in constructing outdoor structures for livestock. Cattle chew on such wood periodically and this provides a source of dioxin in meat that could ultimately end up in biosolids used as a soils amendment (Chaney pers. comm.). The EPA risk assessment was based on those conditions considered to represent the worst-case conditions of exposure through various pathways (see Appendix E, Part 2).

Of all the SOCs, pesticides are probably the most researched. The levels found in biosolids, however, are minuscule compared with the levels of those used directly on farms and with typical environmental levels. The epidemiologic study of human exposure on 47 farms in Ohio to biosolids showed no significant differences in health that could be related to biosolids land application, including health effects that could be related to the presence of SOCs in biosolids (Dorn et al. 1985 and National Academy of Sciences 1996).

Currently, the Part 503 rules do not set standards or require testing of biosolids for SOCs. However, the proposed GO monitoring program would require testing of biosolids for PCBs, aldrin, dieldrin, and semivolatile organic compounds. EPA is in the process of proposing a dioxin limit for biosolids, however, and if and when such a limit is developed, it would be applicable to biosolids use. Until there is sufficient justification (i.e., a potentially significant health risk associated with biosolids is identified), it is unlikely that regulations will be developed to establish limitations on the SOCs in biosolids.

The potential for increased risk of disease resulting from the ingestion of SOCs present in biosolids used in land application is considered minor. Most SOCs are found in very low concentrations (U.S. Environmental Protection Agency 1995) and at levels that pose no excessive risk to human health through any of the potential exposure pathways. There are no reports of adverse human acute and chronic toxicity effects resulting from ingestion of plants grown in biosolids-amended soils (National Academy of Sciences 1996). Few adverse human health effects have been found in studies where treated biosolids were fed directly to animals (National Academy of Sciences 1996). This impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

Health concerns regarding grazing animals are discussed above and in Chapter 4, “Land Productivity”. Mitigation Measures 4-2 and 5-2 would increase the period after biosolids application during which grazing is prohibited from 30 days to 90 days. These measures would also increase the level of human health protection associated with SOCs in biosolids.

### Impact: Potential for Increased Incidence of Disease Resulting from Ingestion of Groundwater Contaminated by Biosolids-Derived Pollutants or Pathogens

As the amount of biosolids applied to land increases with population growth, the potential for leaching of biosolids-derived contaminants to groundwater will increase, potentially resulting in effects on public health. The pathogens that may be present in biosolids that have the greatest chance of reaching groundwater are viruses. As discussed in Chapter 3, "Soils, Hydrology, and Water Quality", the leaching of nitrates to groundwater is an issue of concern as well, but only on a very site-specific basis and in terms of cumulative effects. The analysis for Chapter 3 found that for certain geographical areas and geologic and climatic conditions, or in areas where groundwater aquifers are near sources of nitrates or already impaired by nitrates, the impacts from application of biosolids are considered potentially significant. As discussed in the setting and Appendix E, nitrates in drinking water can cause a disease in infants and young children called methemoglobinemia. Although the disease is rare, it is an issue of concern, particularly in areas where there are already high nitrate levels in groundwater.

As discussed in Chapter 3, programs are underway under the Safe Drinking Water program to address nitrates and other contaminants that may be introduced into drinking water supplies. The RWQCBs are involved in these programs and the GO will provide a further tool to protect drinking water supplies and provide monitoring data to assess environmental quality. Under the proposed application rates required under the GO, there should be no adverse impacts on public health related to nitrates and biosolids land application.

Contamination of groundwater with biosolids-related trace metals also should not be an issue of public health concern because of the restrictive provisions of the GO. If the groundwater is a part of a basin that is tapped for a potable water supply, public health will be protected by compliance of the water purveyor with existing drinking water standards for trace metals content. For other water users tapping the groundwater aquifer, the GO has protective provisions in the form of prohibitions against groundwater exceedances of drinking water standards, setback requirements, requirements for minimum depth to groundwater, specified application rates, and monitoring requirements.

Unless there are very porous soils with fractured rock underlying them, abandoned wells that are not properly sealed, and high rates of irrigation or rainfall to provide a means of transport, it is unlikely that any viruses present in biosolids will reach groundwater. The GO contains sufficient provisions to prevent such occurrences (setbacks, minimum distances to wells, runoff controls, and prohibitions on long-term storage piles where concentrations of pathogens might be higher if leached to groundwater). The direct effect of biosolids application is considered less than significant.

**Mitigation Measures:** No mitigation is required.

Although the direct effect of land-applied biosolids on groundwater quality, and therefore public health, is considered less than significant, there are circumstances in California under which cumulative increases in groundwater nitrate levels could pose a significant health risk. See Chapter 13, "Cumulative Impacts", for a full discussion of this issue.

## Impact: Potential for Increased Incidence of Acute or Chronic Disease Resulting from Human Exposure to Aerosols and Wind-Blown Particulates from Biosolids Stockpiling, Composting, or Land Application

As population growth occurs and the beneficial use of biosolids increases, stockpiling, composting, and land application of biosolids will increase, leading to potential increases in human exposure to aerosols and wind-blown biosolids. However, increased exposure is not expected to correlate with increases in disease for the reasons described below.

As described above under "Environmental Setting" and in Appendix E, various studies reported in wastewater aerosol symposium proceedings and other research have shown that aerosols from spray irrigation of treated wastewater do not pose a significant threat to public health. Research on aerosols from land-applied biosolids has shown similar results. For biosolids land application, recent research has been conducted at the Sierra Blanca Ranch in far west Texas in the Chihuahuan Desert, where rainfall is limited, summers are hot and dry, wind velocities are high, and relative humidities are low (Pillai et al. 1996). Temperatures range from 70EF in November to 84EF in August and mean wind speeds range from 2 to 5 mph. Anaerobically digested sludge from New York City is transported by rail to the site and applied as a cake at a rate of 3 dry tons per acre. Residents of the town of Sierra Blanca, about 4 miles from the closest sludge application site, expressed serious concerns about health effects that could result from the sludge-application operation.

This study found the highest levels of bacteria in the immediate vicinity of the hopper loading area, where the sludge was agitated during loading. The highest bacterial population densities were found during low-wind conditions, with counts ranging between 56 and 630,000 colony forming units (CFU) per cubic meter at the hopper loading area and 4,200–250,000 CFUs per square meter within 15–30 meters of the application site. The bacteria detected were aerobic heterotrophic bacteria; none were the pathogenic bacteria, such as salmonella, found in the biosolids. The absence of fecal coliforms and fecal streptococcus in the air samples was notable, considering that the levels measured in the sludge piles at the hopper loading area were 23,000 most probable number per gram (MPN/gm) of wet sludge for *Salmonella* spp., 1.1 x $10^8$ MPN/gm for fecal

coliforms and 3.5 x $10^6$ MPN/gm for fecal streptococci (Pillai et al. 1996). None of the sites was positive for coliphage (representative of viruses).

The authors of the Sierra Blanca report concluded that, unlike spray irrigation sites, sludge application sites may have minimal potential for generating aerosols under low wind conditions; no aerosols were detected in the study at distances greater than about 30 meters (100 feet) from the hopper loading site. This study confirms the results of others that there is a lack of viruses in air found at wastewater application sites (Brenner et al. 1988, Fannin et al. 1985) under conditions of high agitation and high likelihood for aerosol formation. The results suggest that land application of municipal sludges at 3 dry tons per acre poses little risk of airborne transmission of bacterial pathogens (under geographical and weather conditions similar to those of parts of California) and the population center downwind (4 miles away in the Texas case) is not affected by airborne bacterial pathogens from the sludge application sites. Most biosolids that are land applied have a solids content of about 25% and do not form aerosols in the same volume as spray irrigation. Most liquid biosolids are injected. There are no spray irrigation operations of biosolids in California such as those in use in silvicultural operations in Washington.

Studies of dust generation at the Sierra Blanca site have shown that only 0.026 g of particulate matter had accumulated in samplers after 25 days of continuous sampling (Harris 1996). This is an extremely low level of particulate material.

Bacteria and viruses exposed to air have a much greater die-off rate than those in soils or water as a result of dessication and ultraviolet radiation; thus, any pathogens that may be present in air will not survive as long as those that are buried. The absence of bacteria in particulate samples at distances of more than 30 meters from the hopper loading site indicate minimal aerial transport of biosolids-derived aerosols or dust. Good site management practices, as suggested in Mitigation Measure 5-1, would be appropriate to minimize worker exposure to biosolids-related aerosols.

Isolation of the biosolids application sites from the general public is a major factor in minimizing any potential risk from aerosols and particulates. As the land application parcels are expanded under the GO, environmental commitments and operating criteria contained in the GO will protect public health. The GO acknowledges the concern over potential health effects of dust generated from biosolids. The GO specifies that biosolids application operations and biosolids incorporation activities cannot cause the release of visible airborne particulates from the application site. Because of the safeguards in provisions of the GO against exposure of humans to airborne particulates from biosolids and the scientific evidence available concerning the low probability of human effects associated with aerosols from biosolids, this impact is considered less than significant.

It is noteworthy to add that research on this issue is continuing and that the present lack of information or reported disease associated with exposure to aerosols near biosolids land application sites should not be taken as an indication that there are no risks. Everything that humans do has risks, but as stated in the draft EIR, these risks are considered less than significant for the general population. For active workers in the vicinity of biosolid mixing and application sites, it can be anticipated that exposure to higher levels of potential aerosols (mainly fine particles to which pathogenic microorganisms could attach) is likely.

Under high wind conditions or when Class B biosolids or certain compost products are loaded or spread, there may be exposure of applicators or workers to aerosols or dusts that can contain potentially viable pathogenic microorganisms. To date, health risks are not deemed to be significant; therefore, this impact is considered less than significant. However, the following mitigation measure is recommended and is not required to reduce the level of significance for this impact.

**Mitigation Measure 5-3.** As part of good management practices, it is recommended that workers who are loading or working near sites where Class B biosolids are mixed or loaded or are applied by surface spreading wear respirators or masks to protect against inhalation of aerosols or fine particles derived from the biosolids being handled.

**Mitigation Measures:** No mitigation is required.

## Impact: Potential for Increased Risk of Disease Resulting from Contact with Biosolids Spilled during Transport from Point of Generation to Application Site

As more biosolids are transported from places of generation to application sites, the potential spills will increase. However, unless a spill results in an injury accident with subsequent human exposure to biosolids, it is unlikely that a spill of biosolids would result in any threat of humans contracting disease. The GO includes numerous provisions that ensure the safety of biosolids transport. The proposed GO requires that the biosolids hauler be trained in spill response procedures designed to prevent spilled biosolids from remaining on roads, being washed into storm drains or waterways, or contaminating groundwater. Specifications in the GO mandate that each truck carry a copy of an approved spill response plan. Therefore, this impact is considered less than significant. No mitigation is required.

### Impact: Potential for Exposure of Residents and Agricultural Workers to Unsafe Levels of Radionuclides After Long-Term (50- to 100-year) Application of Biosolids

Naturally-occurring and man-made radioactive materials may enter the wastestream that is being treated at individual POTWs. In some cases, where excessive amounts of radioactive materials are present, this can create hazards for personnel at the POTW and, if conditions persist, to those who contact lands to which biosolids produced by that plant are applied. (Interagency Steering Committee on Radiation Standards. 2003a) Any hazards that exist at POTWs would exist whether or not the plant was producing biosolids and whether those biosolids are applied to land, so impacts on plant personnel are not pertinent to this PEIR.

The potential for radioactive materials to contaminate agricultural fields is a concern of this PEIR. The ISCORS has opined that over the long-term, that is over periods of 50 to 100 years, the application of biosolids containing radioactive materials to fields may lead to impacts on the health of residents and agricultural workers. (Interagency Steering Committee on Radiation Standards. 2003a) Conditions vary widely between POTWs and, based on the survey prepared by ISCORS, radioactive material in biosolids is not a widespread problem. (Interagency Steering Committee on Radiation Standards. 2003b) Further, POTWs may take specific actions that will help them to avoid endangering personnel and keep contamination levels to acceptable levels. (Interagency Steering Committee on Radiation Standards. 2003c)

This impact is considered significant. However, implementation of Mitigation Measure 5-3 will reduce it to a less than significant level.

**Mitigation Measure 5-4:** POTW Operators Maintain Awareness of Potential Radioactive Materials in the Wastestream. As part of its GO, the SWQCB shall require the operators of POTW that produce biosolids that are to be applied to land to follow the recommendations contained in the ISCORS Assessment of Radioactivity in Sewage Sludge: Recommendations on Management of Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works for screening, identification, and consultation.

## Impacts of Other Activities

### Silvicultural Use

The GO would regulate the beneficial use of biosolids for silvicultural activities. It is anticipated that in California this use would mainly occur in tree farming rather than in large-scale forestry operations as in Washington, where liquid biosolids application is conducted to promote silviculture. The information presented above regarding survival of pathogens and levels of trace metals and other contaminants in biosolids, the low probability of aerosol formation, and the lack of evidence of health effects associated with direct contact with biosolids or contact with wind-blown particulate matter from application sites applies to silvicultural uses of biosolids as well as agricultural uses.

The literature on biosolids management in the Pacific Northwest has been extensively reviewed by Henry (1997) for information on environmental effects related to silvicultural operations. Also, the health effects associated with silviculture have been addressed in detail by the Municipality of Metropolitan Seattle in Munger (1983). This work concluded, based on the known quantities of pathogens in Seattle area biosolids and information on infectious dose and level of environmental mobility of pathogens and other contaminants in forestland, that biosolids would pose little or no risk to public health.

Conditions in California (less rainfall and warmer, dryer weather with less humidity than in Seattle) are more conducive than conditions in Washington to pathogen die-off. It is therefore likely that the health risks associated with use of biosolids in silviculture in California would be less than those found for the Seattle area for similar pathogen levels. The runoff control and stream buffers required by the GO would also apply to silvicultural sites, whether the particular use is a small tree farms or a large forestry operation. Based on the results of studies cited above and the controls contained in the GO, this impact is considered less than significant.

**Mitigation Measures:** No mitigation is required.

## Horticultural Use

Horticultural operations may use biosolids to grow turfgrass, cut flowers, and container-grown landscape plants and live vegetable seedling plants for home garden transplanting. The impacts associated with such activities are similar to those cited above for direct contact and aerosols. Use of Class A biosolids for larger scale landscaping projects would be subject to the GO if the material were applied at high rates. Commercial sales of bagged product for smaller scale commercial and residential uses in horticulture would not be governed by the GO.

Use of composted biosolids in bulk can pose a health risk associated with exposure to high concentrations of *Aspergillus* fungal spores, which can cause allergies and pulmonary disease, particularly in susceptible or immunocompromised persons (see

"Environmental Setting" and Appendix E for further discussion). However, the same effects can be found in gardeners working with composts that are not derived from biosolids (Zuk et al. 1989).

Because there would be little chance of ingestion of flowers or other ornamental plants, there is no health risk associated with consumption of such plants grown using soil amended with biosolids. In the worst case, someone may grow the seedlings to full size and eat the food grown in the biosolids-amended container plant; this is an issue of public health concern. This would be a one-time event, rather than chronic ingestion such as the long-term (70-year) exposure to foods grown with biosolids studied by EPA in its risk assessment, and would pose little risk to health.

Use of Class A material and the numerical limits placed on exceptional quality biosolids for unrestricted use should result in protection of the general public from adverse health effects. This impact is considered less than significant. No mitigation is required.

## Land Reclamation

The GO would regulate the use of biosolids for reclamation activities. The reclamation uses could include rehabilitation of mined sites, one-time heavy applications to closed landfills to create a condition conducive to planting of a vegetative cover, or the restoration of lands for use as parks, ball fields, or even golf courses. Such intensive uses would normally not occur in areas where there is much public access until the sites are fully reclaimed. Pathogen exposures are assumed to be no greater than for agricultural sites (see "Impact: Potential for Increased Incidence of Disease Resulting from Direct Contact with Pathogenic Organisms at Biosolids Land Application Sites" above). There are no issues related to food grown on the sites, or grazing animals, or wells providing potable water. The same GO restrictions that apply to agricultural application sites would apply to reclamation sites except for limitations related to nitrogen. The proposed GO allows for biosolids application in excess of the nitrogen requirements of vegetation as part of an overall plan for site reclamation. Excess loading of nitrogen could create health risks through nitrate contamination of groundwater used for domestic consumption. The GO requires that, before land application begins, a report must be prepared demonstrating that unacceptable degradation would not occur in these situations. This report must be approved by an RWQCB Executive Officer before the project proceeds. With these controls in place, the public health impacts of biosolids use at reclamation sites are considered less than significant. No mitigation is required.

# Chapter 6. Land Use and Aesthetics

# Chapter 6. Land Use and Aesthetics

## Environmental Setting

### Regional Settings

Typical regional settings for the evaluation of land use and aesthetic impacts are described below. These particular regions are described because land application of biosolids will most often be proposed under the GO in settings similar to these. The presentation of these descriptions is not intended to preclude the applicability of impact analyses to other regions of the state, however. Figure 6-1 depicts the regions discussed.

#### Central Valley

The Central Valley encompasses approximately 60,000 square miles extending from Kern County in the south to Shasta County in the north (Jensen pers. comm.). More than 90% of the land area of the flatter, lower elevation portions of the valley consist of irrigated agricultural land. The total population of the Central Valley is approximately 7 million people; most of that population is concentrated along State Route 99 from Bakersfield to Sacramento and along Interstate 5 and State Route 99 north of the Sacramento urban area (California Department of Finance 1998). Agricultural development in the southern portion of the valley varies from small farms in the east to enterprises of several thousand acres in the west; in the central and northern portions of the valley, agricultural operations are mostly small and medium sized.

#### Lahontan

This area encompasses the southern Sierra Nevada and the high desert of California. It is, in general, sparsely populated compared with many other portions of the state. The major population centers are the Lancaster/Palmdale urban area and the Victorville area. Smaller urban developments include Ridgecrest and Barstow.

The region is physically dominated by the eastern slopes of the southern Sierra Nevada and the White Mountains. Smaller ranges are interspersed throughout the region. The western portions of the region are in agricultural use, principally irrigated agriculture. In

the Antelope Valley, north of Lancaster/Palmdale, scattered rural residential development has occurred.

### Southeast

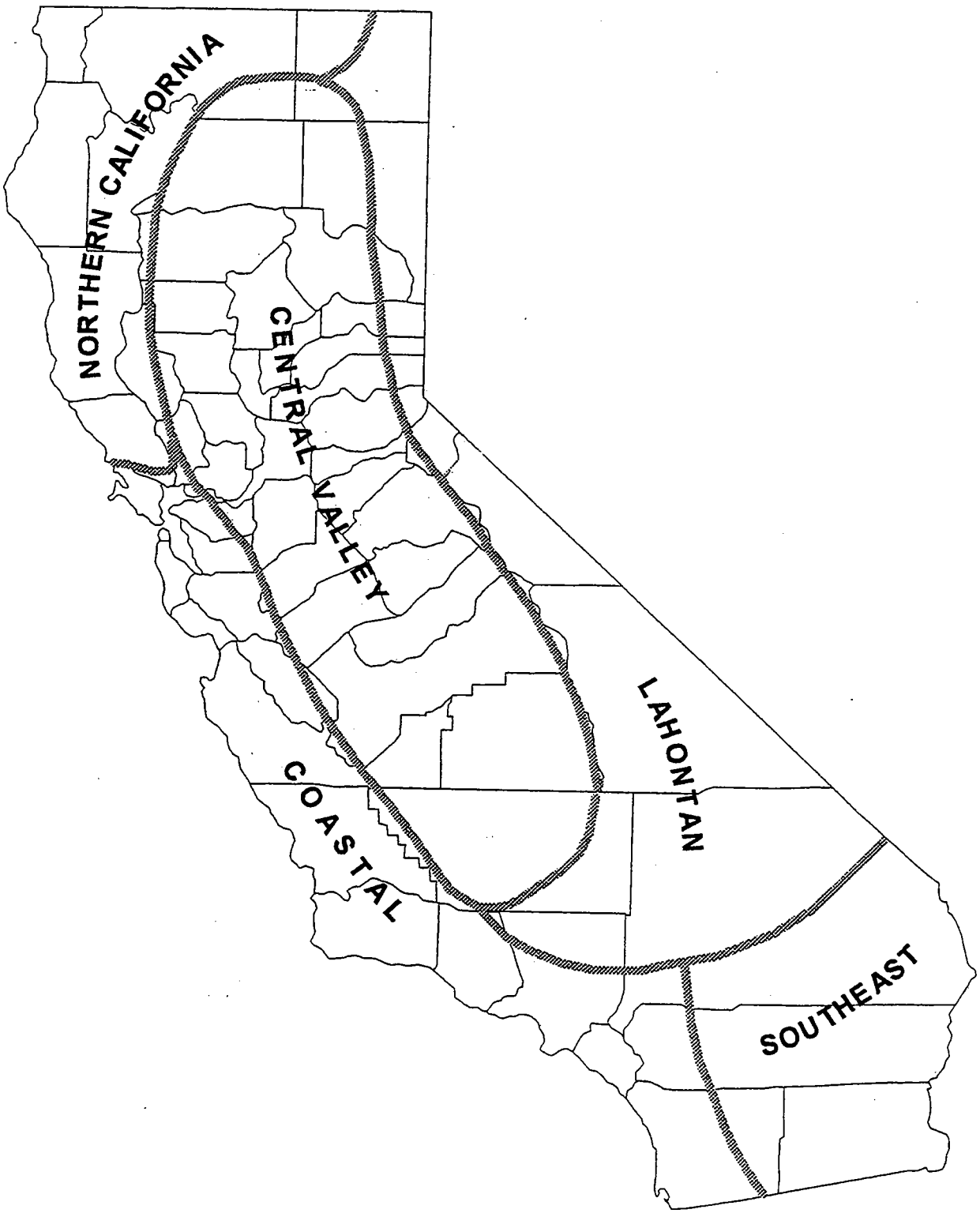
For purposes of this analysis, the southeast portion of the state is defined as the eastern, non-urbanized slopes of the Coast Ranges and the San Jacinto mountains, the undeveloped areas of the Perris Valley, the Coachella Valley, and the low desert extending to the Colorado River. Where irrigation water is available, intensive agricultural development has occurred. Population is concentrated in the Beaumont-Banning-Palm Springs-Indio corridor, in the Perris Valley-Hemet-Perris-Lake Elsinore area, and at El Centro/Brawley.

### Northern California

This area is defined for purposes of this analysis as the Cascade Range, the Coast Ranges, and the intervening small valleys north of the San Francisco Bay/Delta, not including the Central Valley itself. The valleys in the southern portion of the region are partially to largely urbanized. The principal silviculture operations in the state are conducted in the region's mountains. Agricultural development in the region's valleys, including extensive viticultural development, is generally undertaken on smaller parcels than in the rest of the state. Cattle grazing operations dominate the non-irrigated foothill areas of the region.

### Coastal

The "coastal" region of the state is defined, for purposes of this analysis, as the Coast Ranges from the northern San Francisco Bay area to the Mexican border, the Transverse Ranges of Southern California, San Francisco Bay and the San Francisco Bay/ Sacramento-San Joaquin River Delta (Bay-Delta) region, and the coastal valleys and watersheds. This area includes 80% of the state's population. Urban development occupies most of the region that is not mountainous. Agricultural operations, other than grazing in the foothills, typically are concentrated in small viticultural, dairy, truck garden and horticultural enterprises, rather than the several-thousand-acre holdings common in much of the Central Valley and in the Southeast and Lahontan regions.




Jones & Stokes Associates, Inc.

**Figure 6-1**
**California Physiographic Regions**

## Physical Setting

### ~~Agriculture~~
### ~~Physical~~Agriculture

Physical settings may vary widely with respect to agricultural site. Such physical setting variables may include, but are not limited to:

- distances to nearby residences;
- distances to sensitive receptors such as recreation or assembly areas, high-traffic streets or roads, restaurants, hospitals, and schools;
- prevailing wind conditions; and
- available access routes and near-site development along such routes.

Typical agricultural sites are level areas with relatively large landholdings that are remote from urban centers. Types of crops commonly grown on agricultural biosolids land application sites are row crops that are not typically used for human or dairy animal consumption. Sites are generally reached by county roads with low traffic volumes. The visual impact of such sites is limited, and because they are located away from urban centers and major highways, most people are unaware of their status as biosolids land application sites.

### Silviculture

Physical variables for forested lands are similar to those for agricultural operations. Biosolids would typically be applied as a soil amendment between rows of maturing trees in a commercial tree farm. With respect to silvicultural applications, slope considerations may affect the discharger's approach to preventing potential runoff onto adjacent parcels, including parcels with recreational or residential/urban land uses. Typical silvicultural sites are unlikely to be located on small landholdings or near urban centers.

### Horticulture

Physical variables for horticultural uses are similar to those for agricultural operations. Such variables are of increased concern because of the possibility that horticultural use of biosolids may occur on sites in relatively urbanized areas. Horticultural sites are often

located in transitional areas or on parcels that have been temporarily passed over during the urban expansion process. Slopes are typically gentle to almost flat. Residential uses, including numerous farmsteads, may be present nearby.

### Land Reclamation

The physical setting for land reclamation could include landfills and mining reclamation sites. These operations are likely to occur in rural areas rather than in urban settings because landfills and mining operations are typically not compatible with urban environments.

## Regulatory Setting

Current regulations pertaining to land use/aesthetics and land application of biosolids in California are contained in the ordinances adopted, or under consideration, by 17 of the state's 58 counties and in the site-specific WDRs that have been adopted by RWQCBs.

### County Land Use Regulations and Ordinances

The land use and aesthetics regulations in county ordinances vary widely. Table 6-1 summarizes portions of these ordinances that are related to land use and aesthetics. Such ordinances typically contain the following specifications:

- minimum distances from biosolids application areas to occupied residences,
- minimum distances from biosolids application areas to property lines, and
- maximum wind velocities for application.

### Site-Specific Waste Discharge Requirements

The land use and aesthetics provisions of typical site-specific WDRs, such as those of county ordinances and regulations, vary widely. The following sample provisions for land application of biosolids are from the WDRs for Pima Gro Systems, Inc., and Jerry Menefee, Merced County (Central Valley Region):

- sludge cannot be stockpiled or stored onsite,

## Table 6-1.
## Representative County Ordinance Conditions Pertaining to Land Use or Aesthetic Issues and Land Application of Biosolids

| County | Minimum Distance to Nearest Residence (in feet) | Minimum Distance to Property Line (in feet) | Maximum Wind Velocities for Application (in mph) | Dust Restrictions | Maximum Storage Time on Site | Other |
|---|---|---|---|---|---|---|
| Fresno | — | — | — | — | — | Prohibits the application of any biosolids other than exceptional quality or exceptional quality compost in unincorporated areas of the county. |
| Kern | 500[a] | 50 | 39 | Yes | — | Prohibits the application of any biosolids other than exceptional quality in unincorporated areas of the county. |
| King | 500 | 10 | — | — | — | Class A allowed until 2006. All Biosolids except for Exceptional Quality compost prohibited after 2006 in unincorporated areas of the county. |
| Merced | — | 25 | 20 | Yes | 24 hours | |
| Riverside | — | — | — | — | 24 hours | |
| San Bernardino | 500[a] | — | — | — | — | |
| San Joaquin | — | — | — | — | — | Prohibits biosolids applications in unincorporated areas of the county. |
| Solano | 500 | 50 | 20 | — | 7 days | Prohibits “nuisance”. Prohibits applications inconsistent with the Delta Protection Commission’s Land Use & Resource Management Plan for the Primary Delta Zone. |

# Table 6-1. Continued



| County | Minimum Distance to Nearest Residence (in feet) | Minimum Distance to Property Line (in feet) | Maximum Wind Velocities for Application (in mph) | Dust Restrictions | Maximum Storage Time on Site | Other |
|---|---|---|---|---|---|---|
| Stanislaus | — | — | — | — | — | Prohibits biosolids application. |
| Sutter | — | — | — | — | — | Prohibits biosolids applications in unincorporated areas of the county. |
| Tulare | 500 | 25 | 20 | Yes | 24 hours[b] | Prohibited in or within 660 feet of areas designated as Urban Land Use areas. |
| Yolo | 500 | 25 | 5 | Yes | 48 hr | Draft ordinance prohibits application in Primary Delta Zone. |

_____

[a] Owner residence excepted.
[b] Can be extended for good cause by agricultural commissioner.

- sludge cannot be applied within 25 feet of property lines,
- sludge cannot be applied within 500 feet of domestic water supply wells or occupied dwellings, and
- sludge cannot be applied within 50 feet of public roads.

### Federal Part 503 Regulations

Part 503 regulations include provisions for the reduction of vector attraction (i.e., characteristics of sewage sludge that attract rodents, flies, mosquitos, or other organisms capable of transporting infectious agents) and setbacks from different land uses. Additional information on the Part 503 regulations is included in Chapter 2 and Appendix C.

# Impacts and Mitigation Measures

## Approach and Methods

Because biosolids application is ongoing in California, a considerable amount of information exists concerning the activity, its implications, and the public's reaction to present practices. The analysis of impacts on land use and aesthetic issues involved a review of current biosolids application practices and a review of WDRs for existing sites to identify the types of mitigation measures already in use. The GO and Part 503 regulations also were reviewed to identify the types of land use and aesthetic concerns addressed by the existing regulations. In addition, local ordinances regulating biosolids application were gathered, and land use and aesthetic concerns addressed in those ordinances were identified so that local concerns and responses could be assessed. Factors that could affect impact significance also were considered, including:

- distances to nearby residences;
- distances to other sensitive receptors, such as recreation or assembly areas, high-traffic streets or roads, restaurants, hospitals, and schools;
- prevailing wind conditions; and

- available access routes and near-site development along such routes.

## Thresholds of Significance

Based on the State CEQA Guidelines and professional judgment, it was determined that implementation of the GO would result in a significant impact on land use and aesthetics if it would:

- conflict with local land use plans and ordinances;
- conflict with established land uses;
- ~~conflict with future planned land uses;~~

substantially degrade visual quality in adjacent areas;

- result in objectionable odors, an increase in insects, or dust of biosolids origin in urban areas or at residences adjacent to the disposal site; or
- frequently result in spillage of biosolids on public roads for long periods of time or in large quantities.

## Impacts of Agricultural Use

### Land Use

#### Impact: Application of Biosolids in a Manner And/or in Locations in Conflict with Local Land Use Plans and Ordinances, Including Future Planned Land Uses

Several counties have adopted ordinances that specify locations and applicable setbacks for land application of biosolids. In addition, local land use plans designate areas for future growth. As that growth occurs, conflicts may develop between land applications and urbanizing areas. However, the GO states that it does not preempt or supersede the authority of local agencies to prohibit, restrict, or control the use of biosolids subject to those agencies' control, and the GO requires the discharger to obtain any necessary local governmental agency permits or authorizations prior to the application of biosolids at each

application site. Therefore, this impact is considered less than significant because the GO would not conflict with any local land use plans or ordinances.

**Mitigation Measures.** No mitigation is required.

### Impact: Application of Class B Biosolids at Locations That May Conflict with Existing Land Uses in Urban Areas; Recreation Areas; or Other Sensitive Areas, Including Schools, Hospitals, and Recreation/public Assembly Areas

The GO currently contains specifications, exclusions, and prohibitions designed to minimize conflicts with land uses adjacent to application sites. For example, it specifies areas of the state identified as "unique and valuable public resources" that are not regulated by the GO and for which site-specific permits would be required; it requires compliance with the provisions of Part 503 regulations regarding the land application of biosolids that meet provisions for vector reduction; it stipulates the use of tillage procedures that minimize wind erosion; and it prohibits application within 500 feet of residential buildings. Although the proposed GO identifies the types of land uses where the high potential for public exposure could occur, it does not prohibit the use of biosolids adjacent to these areas. ~~(The application of Class A biosolids would not conflict with these potential adjacent land uses because Class A biosolids have been treated to meet more stringent pathogen reduction standards than Class B biosolids.)~~ The application of Class B biosolids near these sensitive receptors could conflict with the land use (i.e., activities could be disturbed as a result of increased noise, traffic, etc.) This impact is considered potentially significant. To reduce this impact to a less-than-significant level, the SWRCB shall implement Mitigation Measure 6.1.

**Mitigation 6-1: Require injection of biosolids in areas defined as having a high potential for public exposure for Class B biosolids.** The GO will be modified to state that no application of Class B biosolids shall be permitted within an area defined in the proposed GO as having a high potential for public exposure unless the biosolids are injected into the soil.

# Chapter 7. Biological Resources

# Chapter 7. Biological Resources

## Environmental Setting

A great diversity of vegetation and wildlife resources exist in California across a broad range of physiographic regions, from the coast, inland across mountain ranges and valleys, to the deserts along the eastern border. Each of these regions can be further subdivided into many habitats defined by the plant communities present and their associated wildlife species. Habitat types include coastal dunes and scrub, desert and valley riparian, mixed conifer, oak woodland, riverine, and annual grassland, and more human-influenced habitats such as agricultural land, pastureland, and urban areas.

The varied habitat types within California are conducive to a great diversity of plant and animal species, many of which are endemic to the state. As a consequence of habitat conversion to agriculture and residential and commercial development, many of these species have become rare, threatened, or endangered (California Department of Fish and Game 1998a, 1998b). For example, 216 plant species have been state listed as endangered, threatened, or rare under Section 1904 (Native Plant Protection Act of 1977) and Sections 2074.2 and 2075.5 (California Endangered Species Act of 1984) of the Fish and Game Code, 132 plant species have been federally listed as endangered or threatened under the Federal Endangered Species Act of 1973, and another 58 species are proposed or candidates for listing. Additionally, 137 species of animals have been state or federally listed as threatened or endangered and eight animal species are classified as candidates for state listing or proposed for federal listing. Many others are considered special-status species by local, state, and federal agencies but only listed species are included in the following discussion.

This section focuses on the habitat types and resources in areas where biosolids will be applied, including areas with large-scale agricultural, silvicultural, and horticultural uses and those where disturbed lands are being reclaimed. Most of the habitat in areas where biosolids would be applied is agricultural, although some natural terrestrial habitats could also be affected, such as annual grasslands. This analysis focuses on the effects the GO will have on biological resources on a programmatic level instead of on specific effects of individual projects. The following sections are subdivided into specific activities for which biosolids application would be used.

## Agricultural Activities

Agricultural activities include soil cultivation for crop production and raising livestock. Agricultural activities usually take place on flat to gently rolling terrain, primarily in the Central Valley, coastal valleys, the Modoc Plateau, and in desert valleys where irrigation is available, such as the Imperial Valley and the lands adjacent to the Colorado River. Habitat types on agricultural lands include cropland, orchard-vineyard, and pasture.

### Vegetation

Croplands typically comprise row crops, hay, or grains planted in monocultures. Natural vegetation and weeds are generally eliminated by flood irrigation, tillage, and herbicide application. Orchards and vineyards usually contain single tree, shrub, or vine species planted in rows. A low-growing herbaceous understory or cover crop may be present but is generally managed to control its growth. Pasture consists of perennial grasses and legumes planted for livestock forage, although the vegetation also may include native grasses and forbs and weedy non-natives. Pastures are managed to improve forage quality using irrigation, fertilizer application, and weed control. Many natural habitats occur adjacent to agricultural lands, the most common of which are annual grassland, seasonal wetlands, vernal pools, Great Basin grassland, coastal scrub, saltbush scrub, desert scrub, Great Basin scrub, riparian woodland, and oak woodland.

### Wildlife

Although natural communities provide the highest value for wildlife, many of these natural habitats have been largely replaced by agricultural habitats throughout California with varying benefits to wildlife. The intensive management of agricultural lands, including disking, grazing, crop rotation, and the use of chemicals, further reduces the value of agricultural lands for wildlife. In spite of intensive management, however, many wildlife species have adapted to particular crop types and now use them for foraging and nesting. Compared to other agricultural crops, rice and grain are considered high-value crops for wildlife because many species forage on waste grain, and flooded rice fields provide habitat similar to some natural wetlands. Pasture also provides abundant forage and cover. Compared to rice and grains, row crops and orchards provide moderate-quality habitat because they provide only limited cover and foraging opportunities. Vineyards and cotton crops provide low-quality wildlife habitat because they are frequently disturbed and require many applications of herbicides, resulting in limited foraging and nesting opportunities and lack of cover.

Table 7-1 provides a list of representative common wildlife species that could occur in each habitat available for biosolids treatment. The composition of common wildlife species in each of the various habitat/treatment types will vary in each RWQCB region.

### Special-Status Species

**Plants.** Special-status plants would not be expected to occur in croplands, orchards, or vineyards because they are typically eliminated by cultivation. They are also unlikely to occur in pastures because of habitat modification and intense grazing, although some plants could be present in pasture habitat where there is limited habitat alteration or less-intense grazing. Because pasture is not a habitat category used in the California Native Plant Society (CNPS) inventory or the Natural Diversity Data Base (NDDB), no specific information on the occurrence of special-status plant species in pastures was found. The habitat most similar to pasture is grassland and many special-status plants have been reported to occur in grassland habitats (coastal prairie, Great Basin grassland, meadows, and valley and foothill grassland) statewide (Table F-1 in Appendix F). Some endangered grassland species that were once widespread include Bakersfield cactus, California jewelflower, and Hartweg's adobe sunburst.

**Wildlife.** A number of special-status wildlife species could occur in agricultural habitats throughout California. Grain crops and pasture provide important habitat for species such as the Aleutian Canada goose, Swainson's hawk, and greater sandhill crane. Flooded rice fields provide habitat for the giant garter snake and rangeland provides habitat for a number of other listed species including San Joaquin kit fox, blunt-nosed leopard lizard, San Joaquin antelope squirrel, and desert tortoise, which are often in relatively high densities, such as those in the southern San Joaquin Valley (Table F-2 in Appendix F).

## Silvicultural Activities

Silvicultural activities include managing, developing, and harvesting forests and trees for lumber, paper manufacturing, and other products. Silvicultural activities take place primarily in tree-dominated habitats in the northern Coast Ranges, Cascade Ranges, Modoc Plateau, and Sierra Nevada. General categories of tree-dominated habitats include broad-leaved upland forest, montane coniferous forest, north coast coniferous forest, and closed-cone coniferous forest. Tree-dominated habitats also include tree plantations, such as eucalyptus groves in the Central Valley.

## Vegetation

Forest habitats are characterized by stands of trees. Coniferous forest habitats often comprise mixed associations of pines, firs, Douglas-fir, and other conifer species, although stands in closed-cone coniferous forest may be monotypic. In broad-leaved upland forest, conifer species occur in association with broad-leafed such as oaks, tan-oak, and madrone. The forest understory may consist of a dense shrub layer or may be open and parklike. The groundcover is often composed of sparse perennial herbs. In many areas where natural fires have been suppressed, forest stands are now dominated by dense stands of young conifers and support few herbs or shrubs.

Tree plantations are generally similar to orchards and are composed of single tree species planted in rows. A low-growing herbaceous understory or cover crop may be present but is generally managed to control its growth.

## Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur in silvicultural sites throughout the state.

## Special-Status Species

**Plants.** Special-status plants occur in forest habitats (broad-leaved upland forest, closed-cone coniferous forest, lower montane coniferous forest, upper montane coniferous forest, and North Coast coniferous forest) in California, although fewer than in grassland habitats (Table F-1 in Appendix F). Special-status plant species would not be expected to occur in tree plantations because they are usually eliminated by habitat conversion or cultivation.

**Wildlife.** Similar to agricultural habitats, forested habitats throughout California provide habitat for a variety of special-status wildlife species including California red-legged frog, both the California and northern spotted owls, marbled murrelet, and California condor (Table F-2 in Appendix F). However, special-status wildlife species would not be present during biosolids application in tree plantations that would occur after the site has been harvested.

## Table 7-1.
## Characteristics of Habitat Types Authorized for Treatment under the General Order

| Common Habitat | Description | Representative Common Wildlife Species |
|---|---|---|
| **Agricultural Activities** | | |
| Pasture | Irrigated and nonirrigated lands that are dominated by grasses and legumes. Vegetation composition varies with management practices; may include wild oats and alfalfa. | Black-bellied plover, killdeer, long-billed curlew, white-faced ibis, California voles, Botta's pocket gophers, California ground squirrels |
| Orchard-Vineyard | Cultivated fruit or nut-bearing trees and grape vines. Habitat uniform and intensively managed; understory vegetation usually sparse. | Mourning dove, American crow, scrub jay, northern flicker, Lewis' woodpecker, yellow-billed magpies, American robin, deer mouse, gray squirrel, black-tailed hare, racoon, and mule deer |
| Row Crops | Tomatoes, broccoli, artichokes, lettuce, sugar beets, and strawberries. Intensive management and use of pesticides limit use by wildlife. | Swainson's hawks, red-tailed hawks, black-shouldered kites, California vole, deer mouse, and California ground squirrel |
| Grain | Barley, wheat, corn, and oats. Intensive management and use of pesticides limit use by wildlife. | Greater white-fronted geese, tundra swans, red-winged black birds, Brewer's blackbirds, ring-necked pheasants, waterfowl, western harvest mice, wild pigs and tule elk |
| Rice | Has some of attributes of seasonal wetlands but is intensively managed and benefits are reduced. Provides nesting and foraging habitat for waterfowl and shorebirds. Irrigation ditches used to flood rice fields often contain dense cattail vegetation. | Mallard duck, Canada geese, sandhill crane, northern harriers, black-shouldered kites, Virginia rail, American bittern, snowy egret, marsh wren, common yellowthroat, song sparrow, California voles, and deer mice |
| Cotton | Cotton is of limited value to wildlife because of intensive management of the crop and use of chemicals to control pests and disease. | Mourning doves, killdeer, American pipet, horned lark, and house mice |
| Annual Grassland | Open stand of grasses primarily on flat plains to gently rolling foothills, ridges, and south-facing slopes. | Western toad, gopher snake, northern harrier, killdeer, western kingbird, loggerhead shrike, savannah sparrow, pocket gopher, American badger, and coyote |

**Table 7-1.**
**Continued**

| Common Habitat | Description | Representative Common Wildlife Species |
|---|---|---|
| **Silvicultural Activities** | | |
| Montane-hardwood conifer and montane hardwood | Stands with overstory consisting primarily of California black oak, tanoak, Douglas-fir, and madrone with understory of shrubs and sparse herbaceous layer. | Sharp-tailed snake, western rattlesnake, scrub jay, band-tailed pigeon, western gray squirrel, mule deer, and black bear |
| Mixed conifer | Forest stands dominated by associations of ponderosa pine, Jeffrey pine, white fir, incense cedar, Douglas-fir, sugar pine, and black oak. | Ensatina, California mountain kingsnake, Steller's jay, western tanager, northern flying squirrel, and Allen's chipmunk |
| Douglas-fir | Forest stands dominated by Douglas-fir overstory and tanoak understory. | Pacific giant salamander, northwestern garter snake, western flycatcher, golden-crowned kinglet, varied thrush, Trowbridge's shrew, Douglas squirrel, and dusky-footed woodrat |
| Jeffrey pine, ponderosa pine and eastside pine | Open forest stands dominated by Jeffrey or ponderosa pine. | White-headed woodpecker, brown creeper, northern flying squirrel, American martin, and mule deer |
| Eucalyptus | Eucalyptus habitats range from single-species thickets with little or no shrubby understory to scattered trees over a well-developed herbaceous and shrubby understory. Usually eucalyptus forms a dense stand with a closed canopy. | Alligator lizard, gopher snake, crow, raven , barn owl, red-shouldered hawks, red-tailed hawks, and woodrat |
| **Horticultural Activities** | | |
| Row crops | See Agricultural Activities above | |
| Orchard-Vineyard | See Agricultural Activities above | |
| Ornamental | Urban vegetation such as tree grove, street strip, shade tree/lawn, lawn, and shrub cover. Tree groves have a continuous canopy whereas street strip trees may have continuous or discontinuous canopies. | California slender salamander, rock dove, house sparrow, startling,, scrub jay, mockingbird, house finch, wrentit, chesnut-backed chickadee, California quail, plain titmouse, racoon, opossum, striped skunk |

## Horticultural Activities

Horticultural activities include the cultivation of fruits and vegetables as well as ornamental plants. Cultivation of fruits and vegetables is discussed above under agricultural activities. Ornamental plants are cultivated under similar circumstances and in the same general areas as fruits and vegetables. Habitat consisting of large-scale plantings of ornamental plants would be classified as cropland.

### Vegetation

Ornamental plantings generally consists of single annual or perennial herb, shrub, or tree species planted in rows. Natural vegetation and weeds are generally eliminated by tillage and herbicide application.

### Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur in horticultural sites throughout the state.

### Special-Status Species

**Plants.** Special-status plant species would not be expected to occur in ornamental plantings because they are usually eliminated by cultivation.

**Wildlife.** Special-status wildlife species are not typically expected to occur in ornamental plantings because suitable habitat is not generally available (Appendix F). There are exceptions, however—ornamental trees can be used by raptors, including the state-listed Swainson's hawk.

## Land Reclamation Activities

Land reclamation activities are carried out to revitalize or restore lands that are damaged from past or present land uses. Typical reclamation activities include establishing vegetation on mine tailings and revegetating rangelands degraded by severe grazing. Reclamation activities could take place anywhere in the state.

### Vegetation

Vegetation present in reclamation areas depends on the type of activities that have disturbed the landscape. Mining activities remove the vegetation and soil and natural revegetation proceeds slowly, if at all. Other activities, such as heavy grazing, may alter the original composition of the plant community or promote colonization by disturbance-tolerant noxious weeds.

### Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur on land reclamation sites throughout the state.

### Special-Status Species

**Plants.** Special-status plants would not be expected to occur in areas where past disturbance has eliminated the vegetation or where vegetation did not previously grow, such as on mine tailings. In other circumstances, where the vegetation has been altered but not removed, such as in heavily grazed rangeland, it is possible that special-status plants species are present.

**Wildlife.** A number of special-status wildlife species have potential to occur in disturbed areas, including bats (under bridges and in abandoned mines), desert tortoise, blunt-nosed leopard lizard, and San Joaquin kit fox (Appendix F).

## Regulatory Setting

### Federal Endangered Species Act

USFWS (plants, wildlife, and resident fish) and the National Marine Fisheries Service (NMFS) (anadromous fish and marine fish and mammals) oversee the federal Endangered Species Act (ESA). Section 7 of the ESA mandates that all federal agencies consult with USFWS and NMFS to ensure that the federal agencies' actions do not jeopardize the continued existence of a listed species or destroy or adversely modify critical habitat for listed species. A federal lead agency under the National Environmental Policy Act (NEPA) is required to consult with USFWS or NMFS if it

determines that the proposed action "may affect" a listed species. This determination is made through preparation of a biological assessment. USFWS or NMFS will subsequently provide a Biological Opinion on wildlife species that are federally listed, proposed, or candidates for listing as threatened or endangered.

Section 9 of the federal ESA prohibits the take of any wildlife species listed as endangered, including the destruction of habitat that prevents species recovery, without an incidental take permit. "Take" is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting to engage in any such conduct. Wildlife federally listed as threatened are protected from take under Section 4 of the ESA.

The take prohibitions under Section 9 of the federal ESA apply to only fish and wildlife species; however, Section 9 does prohibit the unlawful removal, collecting, or malicious damage or destruction of any endangered plant from federal land. Section 9 prohibits acts to remove, cut, dig up, damage, or destroy any endangered plant in nonfederal areas in knowing violation of any state law or in the course of criminal trespass. Candidate species and species that are proposed or under petition for listing receive no protection under Section 9 of the federal ESA.

## Federal Migratory Bird Treaty Act

The Migratory Bird Treaty Act states that without a permit issued by the U.S. Department of the Interior, it is unlawful to pursue, hunt, take, capture, or kill any migratory bird.

## Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act makes it illegal to import, export, take (which includes molest or disturb), sell, purchase, or barter any bald eagle or golden eagle.

## California Endangered Species Act

The California ESA requires state agencies to seek and conserve threatened and endangered species (Section 2055) and restricts all persons from taking listed species.

DFG administers the act and authorizes take under Section 2081 agreements (except for designated "fully protected species").

The California ESA defers to the California Native Plant Protection Act of 1977, which prohibits importing of rare and endangered plants into California, taking of rare and endangered plants, and selling of rare and endangered plants. State-listed species are protected mainly in cases where state agencies are involved in projects under CEQA. In this case, plants listed as rare under the California Native Plant Protection Act are not protected under the California ESA but can be protected under CEQA. The following activities are exempt from the California Native Plant Protection Act:

- agricultural operations;
- fire control measures;
- timber harvest operations;
- mining assessment work;
- removal of plants by private landowners on private land for construction of canals, ditches, buildings, roads, or other rights-of-way; and
- removal of plants for performance of a public service by a public agency or a publicly or privately owned public utility.

## Clean Water Act, Section 404

The U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) regulate the placement of fill into "waters of the United States" under Section 404 of the Clean Water Act. Waters of the United States include lakes, rivers, streams and their tributaries, and wetlands. Wetlands are defined for regulatory purposes as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3, 40 CFR 230.3). Project proponents must obtain a permit from the Corps for all discharges of fill material into waters of the United States, including wetlands, before proceeding with a proposed action.

The Corps may either issue individual permits on a case-by-case basis or general permits on a program level. General permits are "prior-authorized"— issued to cover similar

activities that are expected to cause only minimal adverse environmental effects. Nationwide Permits (NWPs) are a type of general permit that have been issued to cover particular fill activities. NWPs have a set of conditions (general and Section 404 only) that must be met for the permits to apply to a particular project, as well as specific conditions that apply to each NWP.

# Impacts and Mitigation Measures

## Approach and Methods

This section describes impacts on vegetation and wildlife and proposes mitigation measures to avoid, reduce, or minimize impacts to a less-than-significant level. The evaluation of impacts is supported by the information provided in the environmental settings and by the following assumptions about the GO:

- there would be no staging activities or biosolids applications within 100 feet of wetlands, streams, or water bodies~~;~~ and
- ~~there would be no biosolids application on nonarable lands; and~~

biosolids application could occur in any portion of the state except for the specified GO exclusion areas.

Because biosolids application could occur throughout the state, detailed site- and species-specific effects of biosolids application on native plants and wildlife were not evaluated; the following discussion focuses on general impacts to biological resources and the regulatory consequences of applying biosolids to land for use in agriculture, silviculture, horticulture, and land reclamation.

## Thresholds of Significance

According to State CEQA Guidelines, a project is considered to have a significant impact on biological resources if it would:

- reduce the number of a special-status plant or animal species;
- substantially affect habitat for special-status plant or animal species;

- substantially disturb biologically unique or sensitive natural communities (e.g., riparian woodland, vernal pools, emergent wetland);
- cause long-term degradation of common plant communities or wildlife habitat because of substantial alteration of landform or site conditions (e.g., alteration of wetland hydrology);
- substantially reduce local population size due to direct mortality or habitat loss, lowered reproductive success, or habitat fragmentation;
- substantially interfere with the movement of any resident or migratory wildlife species;
- substantially fragment or isolate wildlife habitats; or
- substantially disturb wildlife by human activities.

## Definition of Special-Status Species

Special-status species are plants and animals that are legally protected under state and federal ESAs or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing. Special-status plants and animals are species in the following categories:

- plants listed or proposed for listing as threatened or endangered under the federal ESA (50 CFR 17.12 [listed plants], 50 CFR 17.11 [listed animals], and various notices in the Federal Register [proposed species]};
- plants that are candidates for possible future listing as threatened or endangered under the federal ESA (62 FR 182:49397-49411, September 19, 1997);
- plants listed or proposed for listing by the State of California as threatened or endangered under the California ESA (14 CCR 670.5);
- plants listed under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);
- plants that meet the definition of rare or endangered under CEQA (State CEQA Guidelines, Section 15380), including those considered by CNPS to be rare, threatened, or endangered in California (Lists 1B and 2 in Skinner and Pavlik 1994);

- animal species of special concern to DFG (Remsen 1978 [birds], Williams 1986 [mammals], and Jennings and Hayes 1994 [amphibians and reptiles]; and
- animals fully protected in California (California Fish and Game Code, Section 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).

## Impacts of Agricultural and Horticultural Use

### Impact: Reduction in the Number of a Special-Status Plant or Wildlife Species

Part 503 in Title 40 of the CFR prohibits the placement of biosolids if it is likely to adversely affect a threatened or endangered species or designated critical habitat. The GO does not address threatened or endangered species in its prohibitions, nor does it require dischargers to disclose information about the actual or potential occurrence of threatened or endangered species in the NOI or direct the RWQCB to address potential effects of biosolids application on threatened or endangered species during its review of the NOI. Therefore, the proposed project has the potential to significantly affect special-status plant and wildlife species by authorizing activities that could result in the reduction in the number of individuals of these species.

Biosolids application in connection with most agricultural and horticultural activities would not have a significant effect on special-status plant species. In general, cultivation would have already removed any previously existing vegetation and altered the physical and biological environment such that natural reestablishment of the indigenous flora and plant community would be precluded.

Biosolids application could result in the loss of special-status plants or animals if it is applied to natural terrestrial habitats (i.e., rangelands) or any lands that have been fallow for more than 1 year. Although the constituents of the biosolids material (e.g., nitrates, trace metals) could have a physiological effect on plants, the primary effects of biosolids application on plants would be physical removal and habitat alteration. Disking to incorporate biosolids into the soil would remove the natural vegetation and alter soil structure, and the biosolids themselves would alter soil chemistry, further altering soil structure. Tilling could result in direct mortality to listed wildlife species that live in burrows (e.g., San Joaquin kit fox, blunt-nosed leopard lizard, and San Joaquin ground squirrel).

Depending on the individual species and the magnitude of the loss or reduction in number of special-status plant or wildlife species, this could be considered a significant impact.

Implementation of Mitigation Measure 7-1 would reduce this impact to a less-than-significant level.

**Mitigation Measure 7-1: ~~Conduct a Site Assessment on Natural Terrestrial Habitat and Fallow Lands for Special-Status Plant and Wildlife Species. The NOI should be modified~~Modify Pre-Application Report and Provide Biological Information.** The pre-application report shall be revised to include a ~~section~~location for the ~~applicant~~discharger to indicate whether the ~~site where biosolids would be applied~~land application site contains natural terrestrial habitat areas or whether it has been fallow for more than 1 year. ~~RWQCB staff will evaluate each project to determine if the biosolids would be applied to natural terrestrial habitats or any lands that have been fallow for more than 1 year and that have not been continually disked. If RWQCB staff determines that natural terrestrial habitats or lands that have been fallow for more than 1 year are present on the project site, a site assessment must be conducted to determine whether there is potential for~~The discharger must submit a report that states whether special-status species ~~to occur and whether or not they could be affected by the application of biosolids. If there are no special-status species present, RWQCB may continue with the project evaluation~~occur on the site. If special-status species ~~could be affected, the project would not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on special-status species, obtains the appropriate permits, and agrees to implement the mitigation~~occur on the site, the report must identify the measures that will be taken to mitigate or avoid impacts on these species; this report must be forwarded to the appropriate regional office of the DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy. The report must be prepared by a qualified biologist.

## Impact: Substantial Disturbance of Biologically Unique or Sensitive Natural Communities

The GO specifically excludes biosolids applications in several areas that have been recognized to contain unique and valuable public resources (See Chapter 2 for a description of these locations). The GO also prohibits biosolids applications in surface waters and on saturated soils, including wetlands. However, the GO does not address unique or sensitive natural communities that lie outside of the specified exclusion areas. Therefore, the proposed project has the potential to adversely affect biologically unique or sensitive natural communities, such as seasonal wetlands and vernal pools.

Biosolids application on cultivated lands would not have an impact on biologically unique or sensitive natural communities because cultivation would have already removed any previously existing vegetation and altered the physical and biological environment such

that natural reestablishment of the indigenous flora and plant community would be precluded. However, the use of biosolids to enhance the fertility of lands considered to be of marginal value as range or cropland or to convert rangeland to pasture or cropland could have a significant impact on sensitive natural communities such as native grasslands, oak woodlands, and saltbush scrub.

The substantial disturbance of more than 10% or 10 acres of a biologically unique or sensitive natural community, whichever is less, would be a significant impact. Implementation of Mitigation Measure 7-2 would reduce this impact to a less-than-significant level.

**Mitigation Measure 7-2: ~~Conduct~~Modify Pre-Application Report a~~ Site Assessment~~nd Provide Information on~~ Natural Terrestrial Habitats for~~ Biologically Unique or Sensitive Natural Communities.** The ~~NOI should~~pre-application report shall be ~~modified~~revised to include a ~~section~~location for the ~~applicant~~discharger to indicate whether the ~~site where biosolids will be applied is an existing agricultural operation or whether it could contain~~land application site contains biologically unique or sensitive natural communities. ~~RWQCB staff will evaluate each project to determine whether the biosolids would be applied to natural terrestrial habitats. If RWQCB staff determines that natural terrestrial habitats are present on the project site, a site assessment must be conducted to determine whether biologically unique or sensitive natural communities occur and whether they could be disturbed by~~If the application ~~of biosolids. If there are no biologically unique or sensitive natural communities present, RWQCB may continue with the project evaluation. If biologically unique or sensitive natural communities are present and more than 10% or 10 acres would be disturbed, whichever is less, the project would not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on biologically unique or sensitive natural communities and agrees to implement the mitigation~~site contains these habitats, the discharger must submit a biological report with the pre-application report that indicates measures to mitigate or avoid impacts on these habitats; this report must be forwarded to the appropriate regional office of the DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy. The report must be prepared by a qualified biologist.

## Impact: Potential for Physiological Effects of Biosolids Application on Wildlife

Animals could potentially be affected by pathogens, organic compounds, or trace metals present in biosolids. Because sewage treatment processes are designed to reduce the concentrations of pathogens contained in biosolids, the risk to wildlife is low (Henry and Harrison 1991). Additionally, the limited research conducted on the possible effects of trace organic compounds in wildlife exposed to biosolids showed no effect on the

reproductive success of bird species and deer mice (Martin et al. 1987). However, biosolids application may affect wildlife by introducing trace metals into the environment. Exposure pathways for wildlife include foraging on plants that have incorporated metals into their tissues, breathing small quantities of aerosol mist during overhead application, drinking contaminated water, breathing dust from dried sludge while foraging, and ingesting soils amended with biosolids (Fitzgerald 1980).

Metal accumulation in wildlife exposed to biosolids can vary with application rates, biosolids quality, and type and quantity of forage. Research does not show clear trends of accumulation; however, most metal accumulation tends to be in the livers and kidneys more than in other tissues. Of all the potential trace metals found in biosolids, cadmium appears to have the greatest potential for harm because of its toxicity and bioavailability (Henry and Harrison 1991).

Studies indicate that trace metals from biosolids application to forest land accumulate at differing degrees in different wildlife species (Henry and Harrison 1991). Small mammals, including meadow voles, deer mice, and cottontail rabbits, appeared to have the greatest exposure and subsequent higher levels of trace metals when compared to birds (Henry and Harrison 1991). However, large concentrations of wintering waterfowl and shorebirds forage in the Central Valley on crops such as rice and could be exposed to higher-than-normal levels of trace metals by eating invertebrates and vegetation. Because birds are highly mobile, can forage offsite, and are present for only part of the year, exposure to trace metals and risk of trace metal toxicity would be reduced.

The GO states that biosolids cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste. Additionally, the material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations on nine trace metals regulated under the Part 503 regulations and one additional metal (chromium) added under the GO. Therefore, discharge prohibitions in the GO for trace metals will keep any potential impact to a less-than-significant level. No further mitigation would be required.

## Impacts of Other Activities

### Silvicultural Use

The use of biosolids for silvicultural use could result in greater impacts on biological resources as those described above under “Impacts on Agricultural Use” because silvicultural sites could have more existing habitat than an agricultural site. Therefore, the potential exists for land application activities to affect special-status plant and wildlife

species or biologically unique or sensitive communities. Mitigation Measures 7-1 and 7-2, described above, would reduce these potential impacts to a less-than- significant level.

## Land Reclamation

Biosolids application could result in beneficial effects in areas where reclamation activities would restore the natural vegetation or where application enhances forage for herbivores. The purpose of biosolids application is to introduce or restore organic material and nutrients to the soil to promote soil fertility and water retention. Restoring the vegetation would provide cover for wildlife. Increasing the nutrients available to plants would enhance the value of forage for herbivorous species. Biosolids application could have an impact on special-status plants or wildlife or biologically unique or sensitive natural communities where reclamation activities would occur in natural terrestrial habitats, such as in degraded rangeland. These impacts will be addressed by Mitigation Measures 7-1 and 7-2. In general, however, biosolids application for reclamation activities would be a beneficial impact and would require no mitigation.

# Chapter 8. Fish

# Chapter 8. Fish

## Environmental Setting

Several of the nine California RWQCB regions (Figure 1-1) are similar in either fish species or aquatic habitat present; therefore, the fisheries setting is discussed according to three regional groupings: Pacific coast (Regions 1-4, 8, and 9); western Sierra Nevada and Central and San Joaquin Valleys (Region 5); and eastern Sierra Nevada, Great Basin, and Colorado River (Regions 6 and 7).

### Regions 1-4, 8, and 9: Pacific Coast

Regions 1-4, 8, and 9 encompass all the Pacific coastal drainages in California. In addition, San Francisco, San Pablo, and Suisun Bay drainages are included in Region 2, as is part of the Sacramento-San Joaquin Delta. Coastal California streams, which usually have steep drainages and a high gradient, are characterized by extreme seasonal variation in flow (Moyle 1976). Many flood in winter but become intermittent in summer. Fishes native to these streams are adapted to these conditions. The northern regions (i.e., Regions 1 and 2) receive the most annual rainfall (see Chapter 3, "Soils, Hydrology, and Water Quality"), and streams in these regions are more likely to be colder and perennial compared to those in the southern regions (Moyle 1976). Despite the latitudinal differences, protected fish species in most of the coastal regions tend to include tidewater goby in the lower reaches of streams; anadromous chinook and coho salmon, steelhead, and lampreys in the middle reaches (anadromous species live most of their adult life in the ocean but return to fresh water to spawn); and a few suckers and minnows in the middle and upper reaches.

#### Special Considerations

The GO prohibits application of biosolids in three areas of Region 2: the Sacramento-San Joaquin Delta, as defined in Water Code Section 12220; Suisun Marsh, as defined in Public Resources Code Section 29101; and the jurisdiction of the San Francisco Bay Conservation and Development Commission, as defined in Government Code Section 66610. The GO also prohibits application of biosolids in the Santa Monica Mountains Zone of Region 4, as defined by the Government Code, Section 33105, and in the

California Coastal Zone, which is generally defined in the Public Resources Code, Section 5093.5, as land extending 1,000 yards inland from the mean high tide line of the ocean. These prohibitions would avoid potential impacts on protected fishes located in these areas (e.g., Delta and longfin smelt and Sacramento splittail in the Sacramento-San Joaquin Delta [Region 2] and southern steelhead in Malibu Creek [Region 4]).

## Region 5: Western Sierra Nevada and Central and San Joaquin Valleys

Streams of the western Sierra Nevada are included in the Sacramento-San Joaquin River drainage, which ultimately empties into San Francisco Bay. This large drainage is isolated by mountains on all sides and supports a variety of aquatic habitat types; consequently, it contains several endemic fish species (Moyle 1976). Streamflow depends primarily on snowmelt but is moderated by major dams on all large rivers except the Cosumnes River. Flow tends to be more constant than in coastal streams; it is greatest in winter and spring and least in summer and fall. Protected species inhabiting western Sierra Nevada and Central and San Joaquin Valley streams and rivers include steelhead, salmon, trout, minnows, suckers, sculpins, and Sacramento perch. Clear Lake (Lake County), the largest natural lake in California, is located in Region 5, as is part of the Sacramento-San Joaquin Delta. Clear Lake is important habitat for Sacramento perch and other native fishes.

### Special Considerations

The GO prohibits application of biosolids in the Sacramento-San Joaquin Delta, as defined in Water Code Section 12220. Impacts on protected fish species (e.g., Delta and longfin smelt, Sacramento splittail) occupying this area therefore would be avoided.

## Regions 6 and 7: Eastern Sierra Nevada, Great Basin, and Colorado River

Regions 6 and 7 encompass the portion of California that is drained internally. Except for water in the Colorado River drainage in Region 7, surface water from these regions does not flow to the sea. Streams tend to originate in mountainous areas and flow downstream into the Great Basin, where the water ultimately evaporates. This typically results in terminal lakes (e.g., Mono Lake) or sinks that are quite warm and saline (Moyle 1976).

Many Great Basin fish (e.g., pupfish) are adapted to extreme conditions. Trout are present at higher elevations although steep gradients often result in cool water temperatures, and hence the presence of trout, at lower elevations (Moyle 1976). Lake Tahoe and Eagle Lake in Region 6 are cool, higher elevation lakes that are important habitat for native fishes. As with the Sacramento-San Joaquin River drainage (i.e., Region 5), isolation of many portions of the eastern Sierra Nevada and Great Basin areas of California has resulted in several endemic fish species. The Colorado River drains a large portion of the southwestern United States and empties into the Gulf of California. Historically, it was deep and sediment laden with areas of strong current and marshes (Moyle 1976). Fish species native to the California portion of the Colorado River are well adapted to these conditions. However, aquatic habitat in the Colorado River has been greatly degraded by construction of dams and use of water for irrigation, which has reduced fish populations; all the native fishes in the California portion are now protected. Overall, protected fish species found in Regions 6 and 7 include trout, minnows, suckers, and pupfish.

### Special Considerations

The GO prohibits application of biosolids in specified locations within six areas of Region 6: Glenshire and Devonshire subdivisions, Town of Truckee; the area southwest of Piute Creek and north of the Susan River; Eagle Lake basin; the Mono-Owens Planning Area; the Antelope Valley Planning Area; and the Mojave River Planning Area. Impacts on protected fish species occupying these areas therefore would be reduced or avoided. Regions 6 and 7 contain several protected species that not only are endemic but have very small ranges or population sizes. These species are inherently at higher risk of extinction. In addition, in the internally drained areas of Regions 6 and 7, pollutants are more likely to become concentrated in terminal lakes and sinks because they are not flushed into the ocean.

# Impacts and Mitigation Measures

## Approach and Methods

The GO was reviewed to identify setbacks from water bodies and other provisions related to water quality. Chapter 3, “Soils, Hydrology, and Water Quality”, was reviewed to determine the GO’s effects on surface water quality. Impacts on fisheries were assessed based on water quality effects.

## Thresholds of Significance

Impacts on aquatic resources were considered significant if they would:

- directly or indirectly reduce the growth, survival, or reproductive success of individuals or species listed or proposed for listing as threatened or endangered under the federal or California ESA;
- directly or indirectly reduce the growth, survival, or reproductive success of substantial proportions of rare or special-concern species populations, or regionally important commercial or game species; or
- substantially reduce the quality and quantity of important habitat for fish species or their prey.

## Impacts of Agricultural Use

### Impact: Potential for Acute Toxicity to Fish from Leaching of Biosolids Constituents from Application Sites to Surface Waters

Surface water increases in metals, organic compounds, and nitrates resulting from land application of biosolids could be acutely toxic to fisheries, depending on the quantity of the contaminant that enters the surface water and the susceptibility of the fish species to the increased level of metals, organic compounds, and nitrates. For these elements to enter the surface water, they would have to leach into the groundwater and travel laterally at least 100 feet (because the GO prohibits land application of biosolids within 100 feet of surface waters). As described in Chapter 3, "Soils, Hydrology, and Water Quality", in most situations, land application of biosolids would not result in surface water quality degradation resulting from leaching of trace metals, organic compounds, or nitrates into the groundwater. In areas with sandy soils underlain by shallow hardpans (present in some desert regions of southern California), leachate could travel greater distances. Small water bodies with no external drainage that are habitat for protected fish species (such as pupfish) could be adversely affected. In these unique conditions, the effect could be potentially significant.

**Mitigation Measure 8-1: Increase Setback from Enclosed Water Bodies If Pupfish Are Present.** Proposed land applications in the habitat range of the pupfish should be reviewed for their proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet should be required. There are several species of pupfish in California. Their current occupied habitat is confined to several small springs, Salt Creek and the Amargosa River in southern Inyo and northern San Bernardino Counties in the vicinity of Death Valley National Monument, and San Felipe Creek and the Salton Sea in Imperial County. Exact locations of habitat can be found in Moyle et al. 1989.

### Impact: Potential for Reduced Fisheries Productivity Resulting from Runoff and Erosion

Land application of biosolids could increase soil erosion and thus increase sedimentation and turbidity of aquatic habitats. Temporary discharges of sediment and suspended solids could cause direct and indirect impacts on fisheries resources. Direct impacts on fish species could include increased mortality and reduced feeding opportunities for sight-feeding fish. Indirect impacts could include asphyxiation of developing eggs under sediments, degradation of spawning and rearing habitats, and decreased food production. However, land application is not expected to result in reduced fisheries productivity because increased sedimentation and water quality degradation in water bodies adjacent to land application sites would be controlled. Provisions in the GO require 100-foot setbacks from water bodies and require erosion control plans to be prepared if slopes exceed 10%. They also prohibit the land application of biosolids that could cause or threaten to cause pollution, as defined in Section 13050 of the California Water Code. Surface water runoff from a permitted application site must be controlled on-site for 30 days following application unless a 33-foot buffer strip of vegetation is present to filter the discharge. In addition, the GO prohibits the application of biosolids in areas where biosolids are subject to erosion or where washout offsite could occur. Generally, the proposed project is not expected to result in runoff and erosion. Runoff and erosion could occur in extreme situations (low-probability storm events, accidental spills), but the potential is low. This impact is considered potentially significant.

**Mitigation 4-1.** Mitigation Measure 4-1 in Chapter 4, “Land Productivity”, would reduce this impact to a less-than-significant level.

## Impacts of Other Activities

## Horticultural Use

The use of biosolids for horticultural purposes (e.g., road medians, parks, and golf courses) would result in impacts on fisheries resources similar to those described above under "Agricultural Use" because the same setback from the application site to water bodies (100 feet) would be required, erosion would not affect adjacent water bodies because Mitigation Measure 4-1 would be implemented (thus, no increase in turbidity would occur), and no degradation of water quality would occur. In addition, horticultural use of biosolids as a planting or potting medium in large nursery operations would not result in impacts on fisheries resources.

## Silvicultural Use

The use of biosolids for silvicultural use generally would pose a risk of impacts on fisheries resources similar to those described above under "Agricultural Use" because the same provisions required for agricultural use would be required for commercial tree operations. In some cases, silvicultural use of biosolids could have a greater risk of impact than those described above for "Agricultural Use" because slopes may be greater at these sites and the application sites could be closer to coldwater fisheries that are less tolerant of eutrophication. Under the GO, if biosolids are applied to ground surfaces having a slope greater than 10%, a report would need to be prepared that identifies specific application and management practices necessary to ensure containment of the biosolids on the application site and to prevent soil erosion. These reports shall be prepared by a certified agronomist, registered agricultural engineer, registered civil engineer, or a certified professional erosion and sediment control specialist and submitted to the RWQCB for approval before the biosolids are applied. Because erosion control plans would be prepared for areas where slopes are greater than 10%, the potential for impacts on fisheries productivity is considered less than significant.

## Land Reclamation

The use of biosolids for land reclamation would result in impacts on fisheries resources that are generally similar to those described above under "Agricultural Use" because the same setback from the application site to water bodies (100 feet) would be required, erosion would not affect adjacent water bodies (thus, no increase in turbidity would occur), and water quality would not be degraded. As described above under "Silvicultural Use", an erosion control plan would be prepared for application sites that have slopes greater than 10% (therefore, although mining reclamation sites could be located in more mountainous areas than agricultural sites, erosion would not affect adjacent water bodies and fish resources). In addition, the use of biosolids as a final

cover material at landfills would not result in impacts on fisheries resources because these resources would not be present at the landfill.

# Chapter 9. Traffic

# Chapter 9. Traffic

## Environmental Setting

### State Highway System

The State of California has more than 15,000 miles of state highways (e.g., interstate highways, U.S. highways, and state routes). The existing state highway system accommodates an estimated 17.3 million automobiles and 5.5 million commercial vehicles that, combined, travel over 140 billion vehicle-miles annually (California Department of Transportation 1999a). Truck volumes along the state highway system have increased proportionately to the state's overall growth, particularly on rural roadways and roadways that provide access to seaports and border crossings.

#### Roadway Maintenance and Funding

The California Department of Transportation (Caltrans) is responsible for maintaining the state highway system through a rehabilitation program and a maintenance program. Pavement rehabilitation improves the roadway and is designed to extend its service life an additional 10 years. Maintenance activities keep the roadway safe and serviceable until rehabilitation is needed. Pavement maintenance activities include: routine maintenance (day-to-day maintenance of roadway), major maintenance (planned work that is generally done under contract) and preventive maintenance (treatments applied when pavement distress is minimal to extend its period of usefulness). Roadway maintenance is primarily funded through the state's tax on the sale of gasoline.

As described above, the California state highway system comprise over 15,000 center-line miles of highway, with over 49,000 lane miles of pavement. Currently, 14,000 lane miles of highway pavement require corrective maintenance or rehabilitation, which amount to nearly 30% of the state highway system (California Department of Transportation 1999b).

## Local Roadway System

The local roadway system comprises roads that are under the jurisdiction of a particular city or county public works department. Local roads provide access to adjacent parcels and also provide a route for traffic from the urbanized areas of the county onto the state highway system.

The primary source of funding for roadway maintenance is also through the state's tax on the sale of gasoline; however, other funding sources such as local taxes (e.g., property taxes) may be allocated for roadway maintenance (Pope pers. comm.). Additionally, projects that involve the generation of large volumes of truck traffic on local roadways may be required to contribute a fee that is applied to maintenance costs resulting from the additional traffic's damage to the roadway surface. For example, Kern County assesses a roadway maintenance fee, on a per-ton basis, to transporters hauling hazardous material to a storage site in the county (Pope pers. comm.).

# Regulatory Setting

The primary transportation-related regulatory issues that are described below involve weight and load limitations for trucks. Biosolids are not considered a "hazardous waste" material and consequently many local jurisdictions do not have regulations or controls regarding the transport of biosolids.

State highway weight and load limitations are specified in the California Vehicle Code, Sections 35550 to 35559. The following general provisions apply to the project:

- The gross weight imposed upon the highway by the wheels on any axle of a vehicle shall not exceed 20,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle, and resting upon the roadway, shall not exceed 10,500 pounds.

- The maximum wheel load is the lesser of the following: a) the load limit established by the tire manufacturer, or b) a load of 620 pounds per lateral inch of tire width, as determined by the manufacturer's rated tire width.

For vehicles with trailers or semi-trailer, the following provision applies:

- The gross weight imposed upon the highway by the wheels on any one axle of a vehicle shall not exceed 18,000 pounds and the gross weight upon any one wheel,

> or wheels, supporting one end of an axle and resting upon the roadway, shall not exceed 9,500 pounds, except that the gross weight imposed upon the highway by the wheels on any front steering axle of a motor vehicle shall not exceed 12,500 pounds, according to California Vehicle Code Sections 35550-35559.

These weight and load limitations for state highways would also apply to county roadways if no limitations were specified by the county.

# Impacts and Mitigation Measures

## Approach and Methods

Traffic impacts associated with implementation of the GO have been evaluated at a program level of detail using available information from existing biosolids application operations. Assumptions regarding the types of transport used and the distances traveled were used to assess the overall significance of project impacts.

Project trip generation is based on an estimate of the number of trucks that would result from a typical daily application of biosolids at a given site. Typically, heavy trucks, with an 80,000-pound weight limit, are used to transport biosolids. With each truck capable of hauling about 25 tons of biosolids, it is estimated that an average per-acre application would generate two round truck trips (Harrison pers. comm.). The total area (number of acres) treated with biosolids on a daily basis at a given site will vary with the technical capabilities of the applicator. Some of the larger operations in the Central Valley have the ability to apply between 1,500 and 2,000 tons per day (Skinner pers. comm.); however, most applicators apply between 40 and 60 acres on a given day (Price pers. comm.). Assuming that biosolids can be applied to an average of 40-60 acres on any given day, it is estimated that an average of 80-120 average daily truck trips would be generated on a given roadway for a short period.

## Thresholds of Significance

According to State CEQA Guidelines and professional judgment, a project is considered to have a significant impact on traffic if it would:

- cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the roadway system,
- substantially increase the traffic delay experienced by drivers,
- result in substantial deterioration of the roadway surface, or
- expose people to roadway safety hazards.

Additionally, the following screening criterion is recommended by the Institute of Transportation Engineers (1989) for assessing the effects of development projects that create permanent traffic increases:

- In lieu of other locally preferred thresholds, a traffic access/impact study should be conducted whenever a proposed development will generate 100 or more added (new) peak direction trips to or from the site during the adjacent roadway's peak hours or the development's peak hours.

For construction projects that create temporary traffic increases, this criterion is considered conservative. However, this criterion is intended to assess the effect of a traffic mix consisting primarily of automobiles and lightweight trucks. To account for the large percentage of heavy trucks associated with the proposed action, the threshold level would be reduced to 50 new peak-direction trips. Therefore, project-related traffic is considered significant if transporting biosolids to an application site would cause a substantial increase in traffic volumes, defined as the generation of 50 or more trips per hour.

## Impacts of Agricultural Use

### Impact: Potential Increase in Traffic Resulting from the Transport of Biosolids

Lands application projects permitted under the GO have the potential to generate an additional 80-120 or more average daily round trips on a given roadway. Project-related traffic would occur throughout the day and is not expected to exceed the threshold of 50 trips per hour. This impact is considered less than significant.

**Mitigation:** No mitigation is required.

### Impact: Deterioration of Roadway Surfaces

Land application projects permitted under the GO have the potential to result in an additional 80-120 or more daily project-related truck trips on a given roadway. The increase in traffic generated in the area of a land-application site would be short term because the increased traffic would occur only when the biosolids are being delivered and applied. As described above, the number of average daily truck trips would not change significantly on existing state or local roadways (which are maintained and will continue to be maintained by Caltrans or local jurisdictions). Because the number of average daily truck trips will not change significantly on the roadway system, no additional maintenance requirements are anticipated for state or local roadways; therefore, this impact is considered less than significant.

### Impact: Potential for Roadway Safety Hazards Resulting from Accidental Spills

The accidental spill of biosolids along project-related access roads could create potential safety hazards and traffic delays for other motorists. However, because under the GO trucks transporting biosolids are required to be leakproof and covered, the potential for accidental spill of biosolids is very low (it would occur only if there was a traffic accident). Additionally, a Spill Prevention Plan must be submitted with the NOI and each truck driver is required to know how to carry out the emergency measures described in the Spill Prevention Plan ( therefore reducing roadway hazards if an accidental spill were to occur). Because of the low probability of accidental spills during the transport of biosolids, this impact is considered less than significant.

**Mitigation.** No mitigation is required.

## Impacts of Other Activities

### Horticultural Use

The use of biosolids for horticultural purposes would generally result in impacts on traffic similar to those described above under “Agricultural Use” because, although existing traffic conditions vary in the areas where horticultural activities would occur under the GO (the existing traffic levels could be greater if the site is closer to urban centers), the same amount of traffic would be generated for the transportation of biosolids to the

horticultural sites (for large road medians, parks, and golf course projects) as described under"Agricultural Use". Therefore, the significance threshold of 50 trips per hour would not be exceeded. Additionally, the delivery of biosolids to large nursery operations would not result in exceedance of the significance thresholds for project-related traffic.

## Silvicultural Use

The use of biosolids for silvicultural purposes would result in traffic impacts similar to those described above under "Agricultural Use". Existing traffic conditions in silvicultural areas would be similar to conditions where agricultural land application would occur, and the same amount of traffic would be generated for the transportation of biosolids to the silvicultural sites (commercial tree farms) as described under "Agricultural Use".

## Land Reclamation

The use of biosolids for land reclamation would result in impacts on traffic similar to those described above under "Agricultural Use" because existing traffic conditions near of reclamation sites or soil borrow areas are expected to be similar to those for agricultural areas. Additionally, the same amount of traffic would be generated for the delivery of biosolids to a land reclamation site as to an agricultural site; therefore, the significance threshold of 50 trips per hour would likely not be exceeded.

# Chapter 10. Air Quality

# Chapter 10. Air Quality

## Environmental Setting

The environmental setting first identifies the air quality criteria pollutants of concern in California and compares them to pollutants that are emitted during biosolids transport and application. Nuisance pollutants, including odors and wind-blown dust, are also described. This discussion explains California's climate and meteorology and their effect on air quality.

### Pollutants of Concern

The GO applies to lands in each of California's 15 air basins (See Figure 10-1). Except for the Lake County Air Basin, each of the 15 air basins has violated either the state or federal ambient air quality standards shown in Table 10-1.

Of the pollutants for which ambient air quality standards have been developed, those emitted in the greatest quantities by biosolids transport and application include carbon monoxide (CO), inhalable particulates (PM10 and PM2.5), and the ozone precursors (oxides of nitrogen [$NO_x$] and reactive organic gases [ROG]).

These pollutants are emitted primarily as exhaust from trucks used to transport biosolids from wastewater treatment plants to land application sites and by biosolids spreaders.

Fugitive dust is also generated from trucks traveling on paved and unpaved roads and by biosolids spreaders operating at farm sites.

#### Attainment/Nonattainment Status

Table 10-2 shows the attainment versus nonattainment status for the 15 California air basins with regard to the pollutants of most concern from biosolids application. In 1998, 76% of all biosolids application within California occurred in the Central Valley (64% within the San Joaquin Valley Air Basin and 12% within the Sacramento Valley Air Basin). Only 5% of total statewide biosolids application occurred within the San Francisco Bay Area Air Basin. The southern California air basins (South Coast Air

District, San Diego Air Basin, Mojave Desert Air Basin, and Salton Sea Air Basin) were combined for 17.8% of statewide biosolids application. No other areas of California had more than 1% of total statewide biosolids application.

A comparison of the attainment/nonattainment status of the 15 air basins listed in Table 10-2 with the quantity of biosolids applied within California shows that each of the areas with substantial biosolids application are nonattainment for state and federal ozone standards. With the exception of the San Francisco Bay Area, those areas are also nonattainment for the state and federal PM10 standards. Consequently, the following analysis focuses on ozone and PM10. CO, which is also emitted in vehicle exhaust, is generally not a health concern in rural, agricultural areas where biosolids are typically applied.

## Ozone

Ozone is a regional pollutant. It is not emitted directly into the air, but is formed by a photochemical reaction in the atmosphere. Ozone precursors, which include ROG and $NO_x$, react in the atmosphere in the presence of sunlight to form ozone. Both ROG and $NO_x$ are emitted by motor vehicles. Because photochemical reaction rates depend on the intensity of ultraviolet light and air temperature, ozone is primarily a summer air-pollution problem and because photochemical reactions take time to occur, high ozone levels often occur downwind of the emission source. Ozone is a respiratory irritant that increases susceptibility to respiratory infections. Ozone is also an oxidant and can cause substantial damage to vegetation and other materials.

State and federal ozone standards have been set for 1-hour averaging times (see Table 10-1). In July 1997, the U.S. Environmental Protection Agency (EPA) also added an 8-hour averaging time for ozone.

## Particulate Matter

Health concerns associated with suspended particulate matter focus on those particles small enough to reach the lungs when inhaled (i.e., 10 microns or less in diameter). Consequently, both the federal and state air quality standards for particulate matter apply only to particulate matter that fit this criteria (referred to as PM10).

State and federal PM10 standards have been established for 24-hour and annual averaging times (see Table 10-1). In July 1997, the EPA also added 24-hour and 8-hour standards for fine particulates defined as particulate matter 2.5 microns or less in

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**Figure 10-1**
**California Air Basins**

## Table 10-1.
## Ambient Air Quality Standards Applicable in California

| Pollutant | Symbol | Average Time | Standard, as parts per million | | Standard, as micrograms per cubic meter | | Violation Criteria | |
|---|---|---|---|---|---|---|---|---|
| | | | California | National | California | National | California | National |
| Ozone | $O_3$ | 8 hours | N/A | 0.08 | N/A | 160 | N/A | If 3-year average of annual third-highest daily 8-hour maximum exceeds standard |
| | | 1 hour | 0.09 | 0.12 | 180 | 235 | If exceeded | If exceeded on more than 3 days in 3 years |
| Carbon monoxide | CO | 8 hours | 9.0 | 9 | 10,000 | 10,000 | If exceeded | If exceeded on more than 1 day per year |
| | | 1 hour | 20 | 35 | 23,000 | 40,000 | If exceeded | If exceeded on more than 1 day per year |
| (Lake Tahoe only) | | 8 hours | 6 | N/A | 7,000 | N/A | If exceeded | N/A |
| Nitrogen dioxide | $NO_2$ | Annual average | N/A | 0.053 | N/A | 100 | N/A | If exceeded |
| | | 1 hour | 0.25 | N/A | 470 | N/A | If exceeded | N/A |
| Sulfur dioxide | $SO_2$ | Annual average | N/A | 0.03 | N/A | 80 | N/A | If exceeded |
| | | 24 hours | 0.04 | 0.14 | 105 | 365 | If exceeded | If exceeded on more than 1 day per year |
| | | 1 hour | 0.25 | N/A | 655 | N/A | N/A | N/A |
| Hydrogen sulfide | $H_2S$ | 1 hour | 0.03 | N/A | 42 | N/A | If equaled or exceeded | N/A |
| Vinyl chloride | $C_2H_3Cl$ | 24 hours | 0.010 | N/A | 26 | N/A | If equaled or exceeded | N/A |
| Inhalable particulate matter | PM10 | Annual geometric mean | N/A | N/A | 30 | N/A | If exceeded | N/A |
| | | Annual arithmetic mean | N/A | N/A | N/A | 50 | N/A | If exceeded |
| | | 24 hours | N/A | N/A | 50 | 150 | N/A | If exceeded on more than 1 day per year |

| | | | Standard, as parts per million | | Standard, as micrograms per cubic meter | | Violation Criteria | |
|---|---|---|---|---|---|---|---|---|
| **Pollutant** | **Symbol** | **Average Time** | **California** | **National** | **California** | **National** | **California** | **National** |
| Fine particulate matter | PM2.5 | Annual arithmetic mean | N/A | N/A | N/A | 15 | N/A | If spatial average exceeded on more than 3 days in 3 years |
| | | 24 hours | N/A | N/A | N/A | 65 | N/A | If exceeds 98th percentile of concentrations in a year |
| Sulfate particles | $SO_4$ | 24 hours | N/A | N/A | 25 | N/A | If equaled or exceeded | N/A |
| Lead particles | Pb | Calendar quarter | N/A | N/A | N/A | 1.5 | N/A | If exceeded no more than 1 day per year |
| | | 30 days | N/A | N/A | 1.5 | N/A | If equaled or exceeded | N/A |

Notes: All standards are based on measurements at 25EC and 1 atmosphere pressure.
National standards shown are the primary (health effects) standards.
N/A = not applicable.

## Table 10-2
## Air Quality Requirement Attainment Status by Pollutant and Air Basin

| Air Basin | State Ozone | Federal Ozone | State PM10 | Federal PM10 | State CO | Federal CO |
|---|---|---|---|---|---|---|
| North Coast Air Basin | A | A | N | A | A | A |
| San Francisco Bay Area Air Basin | N | N | N | A | A | A |
| North Central Coast Air Basin | T | A | N | A | A | A |
| South Central Coast Air Basin | N | N | N | A | A | A |
| South Coast Air Basin | N | N | N | N | N | N |
| San Diego Air Basin | N | N | N | A | A | A |
| Northeast Plateau Air Basin | A | A | N | A | A | A |
| Sacramento Valley Air Basin | N | N | N | N | A | A |
| San Joaquin Valley Air Basin | N | N | N | N | A | A |
| Great Basin Valleys Air Basin | T | A | N | N | A | A |
| Mojave Desert Air Basin | N | N | N | N | A | A |
| Salton Sea Air Basin | N | N | N | N | N | A |
| Mountain Counties Air Basin | N | N | N | A | A | A |
| Lake County Air Basin | A | A | A | A | A | A |
| Lake Tahoe Air Basin | A | A | N | A | A | A |

Notes: A = Attainment
N = Nonattainment
T = Transitional

Air basins classified as nonattainment areas have at least one area within that basin that has shown a violation of the relevant ambient standard.

Source: California Air Resources Board 1998.

diameter (PM2.5). Both PM10 and PM2.5 are present in motor vehicle exhaust and are released when dust is kicked up by moving vehicles.

### Nuisance Pollutants

Nuisance pollutants that could potentially be released by implementation of the proposed project include odors and visible dust. These pollutants are regulated by nuisance rules incorporated into air district regulations. The purpose of nuisance rules is to protect the health and safety of the public by preventing the release of air contaminants that endanger the comfort, health, or safety of the public. However, nuisance rules are specifically written to exclude odors emanating from agricultural operations related to crop growing and maintenance.

## California Climate and Meteorology

Because of the strong influence of the Pacific Ocean, the Coast Range, and the Sierra/Nevada Mountains, variations in climate in California run in a general east-to-west direction. California's climate varies from Mediterranean (most of the State) to steppe (scattered foothill areas), to alpine (high Sierra), to desert (Colorado and Mojave Deserts).

The Sierra Nevada and Cascade Ranges act as barriers to the passage of air masses. During summer, California is protected from much of the hot, dry air masses that develop over the central United States. Because of these barriers, and California's western border of the Pacific Ocean, summer weather in portions of the State is generally milder than that in the rest of the country and is characterized by dry, sunny conditions with infrequent rainfall.

In winter, the same mountain ranges prevent cold, dry air masses from moving into California from the central areas of the U.S. Consequently, winters in California are also milder than would be expected at these latitudes.

# Regulatory Setting

## Federal Regulatory Environment

The federal Clean Air Act (FCAA) was passed in 1963 by the U.S. Congress and has been amended several times, most recently in 1990. The FCAA required the EPA to establish national ambient air quality standards for air pollutants or air pollutant groups that pose a threat to human health or welfare. EPA established the National Ambient Air Quality Standard (NAAQS) for six criteria pollutants: ozone ($O_3$), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), lead, particulate matter and CO (see Table 10-1). Two separate standards have been set for particulate matter, one for particulate matter 10 microns or less in diameter (PM10), the other for particulate matter 2.5 microns or less in diameter (PM2.5).

Air basins that have not violated an ambient air quality standard are considered to be in attainment for that standard. Conversely, air basins with recorded violations of an ambient air quality standard are classified as nonattainment areas for that pollutant. Most air basins are classified as nonattainment areas for one or more pollutants. Also, for specific pollutants such as PM10, California has more stringent standards than those imposed by federal regulations. Consequently, an air basin may be classified as a nonattainment area for the state PM10 standard although it is in attainment for the federal PM10 standard.

Air basins classified as nonattainment areas for the NAAQS must prepare state implementation plans (SIPs) that describe the specific steps that will be taken to bring the nonattainment area into compliance. Those steps primarily include rules and regulations to limit air emissions from specific stationary and mobile sources. The FCAA contains specific dates by which the NAAQS must be met before federal sanctions can be imposed.

## California Regulatory Environment

The California Clean Air Act (CCAA) of 1988 differs from the FCAA in that there are no sanctions or specific deadlines for attainment of the California Ambient Air Quality Standards (CAAQS), also shown in Table 10-1. The CAAQS were enacted in response to the need for new air quality requirements. Under this act, air quality attainment is required at the earliest practicable date and reasonable progress toward attainment must be made each year.

Similar to the FCAA, the CCAA requires attainment plans for designated nonattainment areas, which are areas that currently violate the ambient air quality standards. The California Air Resources Board (ARB) is responsible for preparing the plans for meeting the NAAQS and CAAQS and has delegated to the California air districts the responsibility for preparing air quality attainment plans. The CCAA, unlike the FCAA,

does not require an air quality attainment plan for areas designated as nonattainment for the PM10 CAAQS.

SB 700 was signed by Governor Davis in September 2003 (Chapter 479, Statutes of 2003). This bill removes prior agricultural exemptions from air quality standards and requires that air districts in non-compliance for PM10 implement agricultural control measures by 2007. This applies to any equipment used in agricultural operations in the growing of crops or the raising of fowl or animals (California Legislation 2003).

### Local Air Quality Regulatory Environment

The ARB has delegated much of its air pollution control authority to local air pollution control districts and air quality management districts. California's 15 air basins are identified in Figure 10-1. For some air basins covering more than one county, a unified air district has been formed to manage air quality issues throughout the basin. In other multicounty air basins, individual county air districts manage air quality in only their county.

Individual air districts or groups of air districts prepare air quality management plans designed to bring an air basin into compliance for nonattainment area pollutants. Those plans are submitted to the ARB for approval and usually contain an emissions inventory and a list of rules proposed for adoption.

## Impacts and Mitigation Measures

### Methods

Air quality impacts associated with treating biosolids would result from the use of biosolids hauling and application equipment, odors resulting from biosolids storage and application, wind-blown emissions of particulate matter (PM10 and PM2.5) and toxic air pollutants, and fugitive dust resulting from vehicle operations.

Vehicle exhaust and fugitive dust emissions were estimated using the California Air Resources Board's EMFAC7G vehicle emission factor model included within the URBEMIS7G model. The vehicle emissions analysis was used to determine the number of vehicle miles traveled (VMT) per day that could be generated by biosolids operations without exceeding the air emission significance thresholds (described below).

To control odor associated with biosolids operations, the GO limits the maximum amount of onsite storage to 7 days and requires that storage areas be covered between October 1 and April 30. Additionally, biosolids must be transported in covered, leakproof vehicles. Both staging and application of biosolids must comply with several buffer-zone requirements that limit storage and application to 10 feet from property lines, 50 feet from public roads, and 500 feet from residential buildings.

The proposed GO also require biosolids to be at least 50 percent moisture and to be incorporated within 24 hours in arid areas and 48 hours in all other areas. This requirement will prevent the release of PM10 and its constituents classified as hazardous air contaminants.

## Thresholds of Significance

For site-specific projects, criteria established by the applicable air quality management district or air pollution control district are used to determine the significance of impacts on air quality. For this program air quality analysis, implementing the GO would result in a significant impact on air quality if it would:

- conflict with or obstruct implementation of the applicable air quality plan,
- violate any air quality standard or contribute substantially to an existing or projected air quality violation,
- result in a considerable net increase of any criteria pollutant for which the project region is in nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors),
- expose sensitive receptors to substantial pollutant concentrations, or
- create objectionable odors affecting a substantial number of people.

Project-related emissions typically are considered significant if they exceed specific thresholds established by individual air districts. Those thresholds are generally for land use development projects that would result in permanent long-term emissions. In contrast, biosolids application at any one site would be short term because increased traffic volumes and associated air emissions would occur only during the brief period when the biosolids are delivered and applied. Even though traffic and air emissions for

any single biosolids application project would be short-term, area-wide emissions from several biosolids application projects have the potential to create significant air quality impacts.

## Impacts of Agricultural Use

### Impact: Significant Increase in ROG, NOx, and PM10 from Biosolids Transport Vehicles and Biosolids Spreaders

Transporting biosolids from wastewater treatment plants to farms and spreading and mixing biosolids into the soil would generate vehicle emissions and fugitive dust from the use of heavy-duty transport vehicles and farm vehicles. Individually, such actions from a single biosolids project would occur on a short-term basis and would likely have less-than-significant air quality impacts. However, a large number of these actions occurring concurrently have the potential to generate substantial quantities of ozone precursors and PM10.

Individual air districts classified as nonattainment areas for the state or federal ozone or federal PM10 ambient standards are required to prepare state implementation plans (SIPs) and air quality management plans (AQMPs) showing how they will come into compliance with the ambient standards. Those plans include emission budgets for vehicles and nonvehicular sources. Emissions from heavy-duty vehicles, including biosolid transport vehicles, are included within the emission budgets prepared as part of ozone and PM10 AQMPs. Emissions from farm activities, including off-road vehicle travel and wind-blown dust, are also included in the emission budgets of those plans (O'Bannon pers. comm.). Consequently, both on-road and off-road vehicular emissions associated with biosolids application projects are included in the emission budgets in the applicable air quality plans. Because those plans describe the measures that would be used to attain the ambient standards, no additional mitigation measures are needed and the proposed project is considered to have less-than-significant air quality impacts from on- and off-road vehicle emissions.

**Mitigation Measure:** No mitigation is required.

### Impact: Exposure of Sensitive Receptors to Odors

The storage and spreading of biosolids would result in the release of odors in the immediate vicinity of the application operations. For storage and application of biosolids, the GO requires a minimum buffer zone of 500 feet from residences and 50 feet from

public roads. Additionally, biosolids cannot be stored more than 7 consecutive days before application. These restrictions tend to be more stringent than buffer-zone and biosolids storage requirements at most wastewater treatment plants, which have more and varied sources of odors. Unlike wastewater treatment plants, biosolids application projects represent short-term odor sources. Because of the stringent storage and buffer-zone requirements and the short time period during which odors would be generated at application sites, odor and/or odor complaints would be minimal; therefore, this impact is considered less than significant.

**Mitigation Measure:** No mitigation is required.

### Impact: Biosolids Drift Associated with Wind-Blown Biosolids

The potential exists for wind-blown drift of PM10 and toxic constituents during application of biosolids and when biosolids are being incorporated into the soil; however, most application sites are in low-density agricultural areas where wind-blown dust is not a major issue. Additionally, several regulatory requirements of the GO would minimize biosolids drift. These requirements include the following:

- biosolids cannot be stored in piles for more than 7 days after delivery to the site,
- a minimum buffer zone of 500 feet from residences will be maintained, and
- the release of any visible air-borne particulates from the application site during biosolids application or subsequent to spreading onto the soil will be prohibited.

The prohibition against the release of any visible air-borne particulates from the site would limit biosolids application to periods of low winds and would consequently minimize the potential for biosolids drift. This impact is therefore considered less than significant.

## Impacts of Other Activities

### Horticultural Use

The use of biosolids for horticultural purposes would result in air quality impacts similar to those described above under “Agricultural Use” because the same amount of emissions and fugitive dust would be generated from transporting and spreading biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality

impacts resulting from land application of biosolids to a less-than-significant level. Additionally, vehicle emissions generated from transporting biosolids to large nursery operations would be similar to those described above under “Agricultural Use”.

## Silvicultural Use

The use of biosolids for silvicultural purposes would result in similar impacts (although the magnitude of impacts could be less if the biosolids are not incorporated into the soil) on air quality as those described above under “Agricultural Use” because the same amount of emissions and fugitive dust would be generated from transporting and spreading biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality impacts resulting from land application of biosolids to a less-than-significant level.

## Land Reclamation

The use of biosolids for land reclamation would result in similar impacts on air quality as those described above under “Agricultural Use” because the same amount of emissions and fugitive dust would occur from the transporting and spreading the biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality impacts resulting from land application of biosolids to a less-than-significant level.

# Chapter 11. Noise

# Chapter 11. Noise

~~Introduction~~

This chapter analyzes the noise impacts on noise as a result of the GO's regulation of the application of biosolids. Noise-sensitive land uses, existing noise conditions, and regulatory information are also described.

Technical terms and acronyms used in this chapter may not be familiar to the reader. Explanations of these terms, acronyms (including dBA, $L_{dn}$, and $L_{eq}$), and background information on environmental acoustics and State and federal noise regulations are provided in Appendix G.

## Environmental Setting

### Noise-Sensitive Land Uses

Land uses such as residences, health care facilities, public libraries, schools, and parks are typically considered sensitive to noise (sensitive receptors). Land application of biosolids would primarily involve the use of biosolids on traditional agricultural crops, silvicultural or horticultural operations, or in the reclamation of disturbed lands. Because the location of these operations are typically in rural or semirural areas, the primary land uses in the potential application areas would be rural residential and/or agricultural operations. Noise-sensitive land uses would primarily be residences; however, noise-sensitive land uses along the delivery routes may include schools, parks, and/or health care facilities.

### Existing Noise Conditions

The noise in the potential application areas is expected to be typical of a quiet rural environment. The predominant sources of noise would include roadway traffic and equipment noise from existing agricultural operations. Other less-dominant sources of noise would include aircraft that occasionally fly overhead and animals such as birds and insects. Noise levels in these types of environments typically are in the range of 45-55 decibels above reference noise, adjusted (dBA).

# Regulatory Setting

In California, most cities and counties have adopted noise ordinances, which serve as enforcement mechanisms for controlling noise, and general plan noise elements, which are used as planning guidelines to ensure that long-term noise generated by a source is compatible with adjacent land uses. The California Department of Health Services' (DHS's) Office of Noise Control has studied the correlation of noise levels and their effects on various land uses and has published land use compatibility guidelines for the noise elements of local general plans. The guidelines are the basis for most noise-element land use compatibility guidelines in California.

As more fully described in Appendix G, the noise-element guidelines chart identifies the normally acceptable range for several different land uses. The recommended maximum acceptable noise levels for various land uses are shown below in Table 11-1.

### Table 11-1. Maximum Allowable Ambient Noise Exposure for Various Land Uses

| Land Use | Suggested Maximum $L_{dn}$ |
|---|---|
| Residential - Low Density | 60 |
| Residential - High Density | 65 |
| Transient Lodging | 65 |
| Schools, Libraries, Churches, Hospitals | 70 |
| Auditoriums | 70 |
| Playgrounds, Parks | 70 |
| Commercial | 70 |
| Industrial | 75 |

Note: $L_{dn}$ = day-night average sound level.
Source: State of California, Office of Planning & Research 1990.

As shown in Table 11-1, persons in low-density residential settings are most sensitive to noise intrusion, with noise levels of 60 dBA community noise equivalent level (CNEL) and below considered "acceptable". For land uses such as schools, libraries, churches, hospitals, and parks, acceptable noise levels go up to 70 $L_{dn}$ CNEL. For persons in commercial and industrial settings, acceptable levels of noise go up to 70 and 75 $L_{dn}$ CNEL respectively.

# Impacts and Mitigation Measures

## Approach and Methods

Noise impacts associated with implementation of the GO have been evaluated at a program level of detail using standard acoustical modeling techniques. Typical source noise levels for activities associated with the transport and application of biosolids and potential distances from these activities to noise-sensitive receptors were used to predict potential noise levels at these receptors. Potential noise levels were then compared to typical criteria to assess the significance of potential impacts.

The transport and application of biosolids would generate noise levels similar to those shown for backhoes and trucks in Table 11-2. Noise levels at 50 feet from the source would range from 80 to 88 dBA and would be similar to noise levels produced by existing agricultural operations. The GO states that application of biosolids would not be allowed within 500 feet of residential uses. Table 11-3 summarizes predicted noise levels at various distances from an application site based on a source noise level of 88 dBA at 50 feet. These estimates of noise levels take into account distance attenuation, attenuation from molecular absorption, and anomalous excess attenuation (Hoover 1996). At 500 feet from the source, application equipment is estimated to generate noise levels of up to 67 dBA (Table 11-3).

**Table 11-2.**
**Equipment Noise Emission Levels**

| Equipment | Typical Noise Level (dBA) |
|---|---|
| Backhoe | 80 |
| Truck | 88 |

Source: Federal Transit Administration 1995.

## Table 11-3.
## Estimated Project-Related Noise in the Project Area

| Distance Attenuation | |
|---|---|
| **Distance to Receptor (feet)** | **Sound Level at Receptor (dBA)** |
| 50 | 88 |
| 100 | 82 |
| 200 | 76 |
| 400 | 69 |
| 500 | 67 |
| 600 | 65 |
| 800 | 63 |
| 1,000 | 60 |
| 1,500 | 56 |
| 2,000 | 53 |
| 2,500 | 50 |
| 3,000 | 47 |
| 4,000 | 43 |
| 5,280 | 39 |
| 7,500 | 32 |

Notes: The following assumptions were used:
Basic sound level dropoff rate: 6.0 dB per doubling of distance.
Molecular absorption coefficient: 0.7 dB per 1,000 feet.
Anomalous excess attenuation: 1.0 dB per 1,000 feet.
Reference sound level: 88 dBA.
Distance for reference sound level: 50 feet.

## Thresholds of Significance

According to the environmental checklist from Appendix G of the State CEQA Guidelines, a project is considered to have a significant noise impact if it would:

- expose people to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- expose people to or generate excessive groundborne vibration or groundborne noise levels;
- generate a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; or
- generate a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

Section 15064 (I) of the State CEQA Guidelines states that a change in the environment is not a significant effect if the change complies with a standard that is a quantitative, qualitative, or performance requirement found in a statute, ordinance, resolution, rule, regulation, order, or other standard of general application. For the purposes of assessing the significance of noise impacts associated with the implementation of the GO, a noise impact would be considered significant if implementation of the GO has potential to result in an exceedance of noise ordinance criteria typically used in California.

## Impacts of Agricultural Use

### Impact: Exposure of Noise-Sensitive Land Uses to Noise Resulting from the Transport of Biosolids

Application of biosolids on agricultural lands would result in transportation-related noise impacts on sensitive receptors located along delivery or haul routes. As more fully described in Chapter 9, “Traffic”, a typical application of biosolids would generate between 80 and 120 round trips per 40- to 60-acre application site per day or approximately 10 to 15 round trips per hour (based on an 8-hour day). (The number of trips will vary significantly with the size of the application operation). Because the GO

does not specify the use of specific transport routes, it is possible that transporters may use routes through existing residential areas. Because of the potential for project-related truck traffic to result in substantial noise increases to residential areas along transport routes, this impact is considered significant. To reduce this impact to a less-than-significant level, the project applicant will implement Mitigation Measure 11-1.

**Mitigation Measure 11-1: Avoid the Use of Haul Routes near Residential Land Uses.** The project applicant and or transporter will avoid the use of haul routes near residential land uses to the extent possible. If the use of haul routes near residential land uses cannot be avoided, the project applicant and or transporter will limit project-related truck traffic to daylight hours (8 a.m. to 6 p.m.).

### Impact: Exposure of Noise-Sensitive Land Uses to Noise from the Land Application of Biosolids

Application of biosolids at agricultural sites would result in noise impacts associated with operation of the application equipment. Noise levels of the loudest application equipment would be expected to range from approximately 80 to 88 dBA at 50 feet. For the nearest potential residences at 500 feet from the application site, this corresponds to approximately 67 dBA. Because the application of biosolids on agricultural land would emit noise levels similar to those of existing agricultural equipment, application-related noise resulting from the proposed project would be similar to noise from existing agricultural operations. Additionally, potential impacts would be short-term. Therefore, application-related noise impacts are considered less than significant.

**Mitigation:** No mitigation is required.

## Impacts of Other Activities

### Horticultural Use

Although the use of biosolids for horticultural activities could be located in more urban areas than the sites where agricultural land applicant would occur, horticultural activities would generally result in the same type of noise impacts as described above under "Agricultural Use" because sensitive receptors also could be located along the delivery or haul routes or in the area where the land application would occur. These sensitive receptors could be affected by the potential increase in noise if the receptors are located adjacent to delivery or haul routes. No noise impacts would occur to sensitive receptors

located adjacent to the application site because the use of biosolids for large landscaping projects would be indistinguishable from other noise generated from the project and would not be located within 500 feet of a residence.

## Silvicultural Use

The silvicultural use of biosolids would result in similar impacts as described above under "Agricultural Use" because sensitive receptors also could be located along the delivery routes or in the area where the land application would occur and application-related noise would be similar to existing noise levels for silvicultural operations. Therefore, Mitigation Measure 11-1 would be required to reduce transportation-related noise impacts to a less-than-significant level.

## Land Reclamation

The use of biosolids for land reclamation would result in similar noise impacts as described above under "Agricultural Use" because existing noise levels in areas of reclamation sites or soil borrow areas are generally similar to those for agricultural areas. Therefore, Mitigation Measure 11-1 would be required to reduce transportation-related noise impacts to a less-than-significant level. Additionally, the use of biosolids for a final cover material would not affect sensitive receptors because this activity would result in noise levels similar to those at the landfill.

# Chapter 12. Cultural Resources

# Chapter 12. Cultural Resources

## Setting

### Prehistoric Setting

California has a long and complex cultural history with distinct regional patterns that extend back more than 11,000 years. The first generally agreed-on evidence for the presence of prehistoric peoples in California is represented by distinctive fluted spear points called Clovis points. The ancient hunters who used these spear points are presumed to have lived between 10,900 years before present (B.P.) and 11,200 B.P.

Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering. Recent studies suggest, however, that this culture pattern is more widespread than originally described and is in fact found throughout the study area. Radiocarbon dates associated with this period vary between 8,000 B.P. and 2,000 B.P. but cluster in the range of 6,000-4,000 B.P. (Basgall and True 1985).

Cultural patterns reflected in the record, particularly specialized subsistence practices, became better defined within the most recent 3,000 years. The record becomes more complex as specialized adaptations to locally available resources were developed and populations expanded. Along the coast and in the Central Valley, evidence of social stratification and craft specialization is indicated by well-made artifacts such as charm stones and beads, which were often found with burials.

### Ethnographic Setting

California encompasses lands occupied by more than 60 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Before the European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 mutually unintelligible languages representing six major North American stocks (Cook 1976, 1978; Shipley 1978). Similar to today, California was demographically very dynamic in prehistoric

times; the area had the highest population density of any area in North America outside the Basin of Mexico and was home to perhaps one tenth of all people living in North America during the pre-Columbian era.

All native Californians followed a basic hunter-gatherer lifestyle, subsisting through a seasonal round of plant collecting, hunting, and fishing. Reliance on particular resources varied with location and season. For example, acorns were a staple throughout northern, central, and parts of southern California but were merely a supplement to the diet along the northwestern coast and the eastern desert, where they could be obtained only by trade.

Evidence indicates a general evolution from subsistence strategies based primarily on hunting large game to a broad-based economy that placed greater emphasis on diversity. Along with this diversification came population growth and a more settled way of life.

At the time of first contact with Spanish explorers and settlers, most groups inhabiting California had extremely well-developed social, ceremonial, and political structures supported by an elaborate and varied material culture.

Native Californian cultures were initially devastated by contact with Europeans, experiencing an unprecedented loss of population. This demographic collapse was brought on by exposure to new diseases to which the people had no immunity and was hastened by the loss of the land base on which various groups depended for their survival.

## Historic Setting

The earliest European explorers to enter the California region were the Spanish, who traveled by ship along the Pacific coast during the 17th and 18th centuries. Intent on asserting their dominance over the new land, they established 21 missions, four presidios, and four pueblos between San Diego and Sonoma during 1769-1823 (Bean and Rawls 1983).

Following Mexican independence from Spain in 1822, the Mexican government gained control over California. As the power of the Franciscan missionaries weakened, political control of California fell into the hands of a small group of wealthy ranchero families. (Bean and Rawls 1983).

American explorations in California began in the late 18th century with the discovery of the lucrative market for sea otter and beaver pelts. The 1848 discovery of gold by James W. Marshall in the Coloma valley in modern-day El Dorado County, however, created a

gold rush to the region that forever altered the course of California's history. The arrival of thousands of gold seekers in the territory contributed to the exploration and settlement of the entire state. Partly because of its newfound wealth, California attained statehood status in 1850. (Clark 1970).

The establishment of a transcontinental railroad linking the east and west coasts further contributed to California's growth and economic success. With the decline of gold mining in California, agriculture and ranching came to play a more prominent role in the economy of the state. California's natural resources and climate proved well suited for the production of a variety of fruits, nuts, vegetables, and grains. Sheep and cattle ranching also rapidly developed as a major industry in California.

### Regulatory Setting

CEQA is the principal regulatory control addressing impacts on cultural resources in California. Projects with the potential to adversely affect significant cultural resources must be reviewed through the CEQA process. As the designated CEQA lead agency for approval of the GO, the SWRCB is responsible for complying with CEQA's requirements regarding the identification and treatment of historic and prehistoric cultural resources. The State CEQA Guidelines (Pub. Res. Code Section 5097) also specify the procedures to be followed in the event of the unexpected discovery of human remains on nonfederal land. The disposition of Native American burials falls within the jurisdiction of the Native American Heritage Commission.

## Impacts and Mitigation Measures

### Approach and Methods

To determine potential impacts of the project on cultural resources from land application projects under the GO, cultural resources specialists reviewed the requirements of the GO and identified impact mechanisms for cultural resources (i.e., lands that are actively farmed likely would not be subject to impacts on cultural resources).

## Thresholds of Significance

According to CEQA, an impact is considered significant if it would disrupt or adversely affect a prehistoric or historic archaeological site or a property of historic or cultural significance to a community or an ethnic or social group. The State CEQA Guidelines define a significant historical resource as a resource listed or eligible for listing in the California Register of Historical Resources (CRHR) (Pub. Res. Code Section 5024.1). A historical resource may be eligible for inclusion in the CRHR if it:

- is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
- is associated with the lives of persons important in the state's past;
- embodies the distinctive characteristics of a type, period, region, or method of construction, represents the work of an important creative individual, or possesses high artistic values; or
- has yielded, or may be likely to yield, information important in prehistory or history.

If a project proponent agrees to avoid affecting cultural resources identified in the project area, evaluation of these resources for their potential to be listed in the CRHR is not required. If avoidance or protection of a significant cultural resource is not possible, mitigation measures must be implemented, as set forth in Public Resources Code 21083.2(c)-(l). A cultural resource that is not significant need be given no further consideration (Pub. Res. Code Section 21083.2[h]).

## Impacts of Agricultural Use

### Impact: Damage to or Destruction of Cultural Resources on Lands Not Previously Disturbed by Agricultural Activities

The application and incorporation of biosolids in areas where disturbance has already occurred (i.e., areas that are actively farmed) would not represent a new impact on cultural resources. (For agricultural lands, "disturbed" would be defined as lands where crops have been grown within the past 10 years.) Therefore, significant cultural resources, as defined by CEQA, would not be affected on lands currently under

agricultural production. However, if biosolids are applied and incorporated into soil on lands not previously disturbed by agricultural activities, then cultural resources, either known or unknown, could be affected. This impact is considered significant because activities associated with land application of biosolids could affect significant cultural resources. To reduce this impact to a less-than-significant level, the project proponent shall implement Mitigation Measure 12-1.

**Mitigation Measure 12-1: Conduct a Cultural Resources Investigation.** A cultural resources investigation should be conducted before disturbance is permitted on land that has not been disturbed previously. The cultural resources investigation should include a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. This records search should include, at a minimum, contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination can be made regarding whether previously identified cultural resources would be affected by the proposed project and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey may need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If the impact is unavoidable, mitigation should be determined on a case-by-case basis.

## Impact: Damage to or Destruction of Unknown Cultural Resources on Lands Currently in Agricultural Production

On lands currently in agricultural production, grading and tilling activities associated with biosolids use could result in the unearthing of previously unknown cultural resources. If human remains of Native American origin are uncovered, this impact could be significant. To reduce this impact to a less-than-significant level, the project proponent shall implement Mitigation Measure 12-2.

**Mitigation Measure 12-2: Comply with State Laws regarding Disposition of Native American Burials, If Such Remains Are Found.** If human remains of Native American origin are discovered during project activities, it is necessary to comply with state laws relating to the disposition of Native American burials, which are under the jurisdiction of the Native American Heritage Commission (Pub. Res. Code Section 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, excavation or disturbance of

the site or any nearby area reasonably suspected to overlie adjacent human remains will stop until:

- the county coroner has been informed of the discovery and has determined that no investigation of the cause of death is required; and
- if the remains are of Native American origin,
  - the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work, for means of treating or disposing of the human remains and any associated grave goods with appropriate dignity, as provided in Public Resources Code Section 5097.98, or
  - the Native American Heritage Commission is unable to identify a descendant or the descendant failed to make a recommendation within 24 hours after being notified by the commission.

According to the California Health and Safety Code, six or more human burials at one location constitute a cemetery (Section 8100) and disturbance of Native American cemeteries is a felony (Section 7052). Section 7050.5 requires that construction or excavation be stopped in the vicinity of discovered human remains until the coroner can determine whether the remains are those of a Native American. If the remains are determined to be Native American, the coroner must contact the California Native American Heritage Commission.

## Impacts of Other Activities

### Horticultural Use

The use of biosolids for horticultural purposes would result in similar impacts on cultural resources as those described above under "Agricultural Use" if the biosolids are used on areas that have not been previously disturbed (i.e., a new park site or road median) and the biosolids are incorporated into the soil. The incorporation of biosolids into the soil could result in disturbance to cultural resources. However, Mitigation Measure 12-1 included above under "Agricultural Use" would mitigate this impact to a less-than-significant level. Additionally, incorporation of the biosolids into the soil also could result in the potential for unknown cultural resources to be unearthed. Mitigation Measure 12-2, described above, would reduce this impact to a less-than-significant level. Horticultural

use of biosolids as a planting or potting medium in large nursery operations would not result in cultural resources impacts.

## Silvicultural Use

The use of biosolids for silvicultural use could result in similar impacts on cultural resources as those described above under "Agricultural Use" because grading in areas not previously disturbed could adversely affect cultural resources. Impacts on these resources would be dependant on the biosolids application method used and whether the biosolids are incorporated into the soil. If biosolids are incorporated into the soil, Mitigation Measures 12-1 and 12-2 described above would reduce these impacts to a less-than-significant level.

## Land Reclamation

The use of biosolids for land reclamation would result in similar impacts on cultural resources as described above under "Agricultural Use" because most applications would occur to previously disturbed land. If applications occur on lands that were not previously disturbed, Mitigation Measures 12-1 and 12-2 would mitigate the impacts to a less-than-significant level. Additionally, the use of biosolids as a final cover material at landfills would not result in impacts on cultural resources because no cultural resources would be located in the landfill material.

# Chapter 13. Cumulative Impacts

# Chapter 13. Cumulative Impacts

## Overview ~~to~~of Cumulative Impacts Analysis

State CEQA Guidelines Section 15130 requires that an EIR discuss cumulative impacts of a proposed project when the incremental effect of the project 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 current projects, and the effects of probable future projects. The discussion of cumulative impacts must reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone.

## Approach

The cumulative impact analysis must identify related projects through either a "list" or a "projection" approach, summarize effects of the related projects, and contain a reasonable analysis of cumulative impacts and mitigation measures. The list approach ~~includes~~requires compiling a list of past, present, or probable future projects producing related or cumulative impacts~~;~~, including, if necessary, those projects outside the control of the agency.

This cumulative impacts analysis is based on a list approach of similar types of projects that could contribute to cumulative impacts with the implementation of the GO for each resource topic. State CEQA Guidelines state that the lead agency should consider the nature of each environmental resource being examined and the location and type of the project to determine whether to include it as a related project when utilizing the list approach for a cumulative impacts analysis (State CEQA Guidelines Section 15130(b)(1)(B)(1).

# Impacts

Implementation of the GO could result in cumulatively considerable impacts for groundwater, ~~fisheries,~~ biological resources, air quality, and transportation. These cumulative impacts are discussed below.

## Groundwater Quality

### Impact: Cumulative Nitrate Contamination of Groundwater

As described in Chapter 3, "Soils, Hydrology, and Water Quality", land application of biosolids under the GO would result in less-than-significant impacts to surface water and groundwater hydrology because it is unlikely to cause changes in surface or groundwater use, and the GO requires surface runoff to be controlled at sites where biosolids have been applied. The potential impact to water quality from surface water runoff of contaminants is also less than significant because the GO requires a number of measures to minimize the risk of runoff, such as prohibiting direct discharge of biosolids to water, establishing minimum setback distances to streams, and prohibiting application under conditions that could result in surface runoff of biosolids. The potential impacts to surface and groundwater quality from leaching of trace elements and synthetic organic compounds are also less than significant because the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions in California would result in low probabilities for water quality impairment to occur.

Widespread land application of biosolids resulting from many individual permits, in combination with certain environmental conditions, has the potential to contribute to groundwater impairment from nitrates. The impact has the greatest potential to occur in nitrate-sensitive areas, which include the many areas of California where nitrate concentrations are approaching or already exceeding drinking water standards, where beneficial uses have been impaired by nitrate contamination, or where naturally high levels of nitrate exist but may not be identified due to lack of monitoring or use for domestic supplies. Even if biosolids are applied at agronomic rates, groundwater could be significantly impaired by nitrates if the following conditions exist:

- other nitrogen inputs from unregulated applications of fertilizers occur, resulting in total applied nitrogen levels in excess of the assimilative capacity of the soil-cropping system;

- either timing of biosolids application, rate of mineralized nitrogen losses, or irrigation/rainfall water exceeds the soil water-holding capacity and results in nitrates leaching into groundwater;

- other sources of nitrogen are added to the groundwater in areas adjacent to the proposed biosolids applications areas, including dairy and feedlot operations, sewage treatment operations, industrial waste discharges, and on-site septic system leachate;

- long-term overdraft of shallow, unconfined aquifers reduces the existing groundwater assimilative capacity for nitrate contributions;

- biosolids are applied at the agronomic rate and monitoring is not conducted to ensure compliance in areas where depth to groundwater is greater than 25 feet; and

- biosolids are applied at the agronomic rate, but site-specific hydrogeology, groundwater assimilative capacity, or municipal and domestic well vulnerability are not considered.

In California, typical areas where cumulative impacts could occur include existing nitrate-impaired groundwater basins such as the Salinas Valley, Orange County, Upper Santa Ana River watershed, southern San Joaquin Valley, and the sandy soil areas of the central coast and southern California.

This cumulative impact is considered potentially significant because many of the environmental factors and actions described above are either unregulated or administered and regulated by more than one resource management agency. Implementation of the following mitigation measures would reduce the cumulative impact to a less-than-significant level.

**Mitigation Measure 13-1. Minimize Contribution to Groundwater Nitrate Contamination from Land Application of Biosolids Conducted under the GO.** As a condition for the review of each individual NOI submitted for a proposed biosolids application project under the GO, the RWQCB engineer responsible for issuing the NOA would:

- evaluate whether the proposed discharge would occur within an area designated as having existing nitrate contamination problems and

- evaluate whether the proposed discharge would pose an imminent threat of contributing to or causing exceedances of water quality standards for nitrate.

If the responsible engineer finds that either condition exists, the RWQCB would minimize the potential water quality impacts of the project by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the proposed discharge would not cause or contribute to violations of water quality standards. Verification that the proposed project would not cause or contribute to water quality degradation would require that sufficient information be submitted by a qualified civil engineer, agricultural engineer, or other professional hydrogeologist or water quality specialist such that the RWQCB engineer could make a finding that the proposed discharge would be in compliance with provisions of the GO. If the RWQCB finds that modifications to the proposed discharge are necessary for compliance with provisions of the GO, such modifications would consider, but would not be limited to, the following:

- requirements for the discharger to use the services of a certified agronomist, crop advisor, or agricultural engineer to develop additional management practices related to: 1) determining the agronomic rate for biosolids application projects that includes all sources of nitrogen applied to the application site; 2) developing overall farm water, cropping, and fertility management practices; and 3) evaluating the potential for nitrate leaching or impairment of offsite groundwater use;

- requirements of the discharger to provide additional groundwater monitoring in areas where groundwater is found at depths greater than 25 feet or there exist other identified local hydrogeologic conditions that could make the groundwater susceptible to contamination;

- requirements of the discharger to identify whether the proposed biosolids application site is within an area where Drinking Water Source Water Assessment and Protection (DWSWAP) Program setback requirements are implemented for municipal and domestic wells; and

- requirements of the discharger to consider the unique local site and hydrogeologic conditions in the design of the project and/or other groundwater quality management or regulatory programs that are currently active in the area.

**Mitigation Measure 13-2: Reduce Sources of Nitrate Contamination.** The SWRCB would continue to identify causes of cumulative nitrate loading in nitrate sensitive groundwater areas and develop an effective strategy for reducing those sources. An effective strategy may include, but would not be limited to, the following:

- Each RWQCB should continue to implement existing groundwater pollution protection permit programs and policies to prevent or reduce nitrate

contamination of groundwater. Such a program may include evaluating increased enforcement procedure, or modifying the permitting programs for other agricultural activities (e.g., confined animal feeding operations, dairies, poultry farms), industrial and municipal NPDES-permitted discharges of wastes and reclaimed water to land, and NPDES storm water management regulations.

- Other local, state, and federal permitting authorities should evaluate, integrate, increase enforcement of, or modify their existing policies and procedures to reduce the cumulative contribution of nitrates to groundwater. Examples of other regulatory programs that should be evaluated and considered in areas that would have biosolids application include groundwater management programs, residential onsite septic tank system approval, municipal landfill management plans, agricultural cooperative extension programs, and forestry management programs.

~~Fish~~

~~Impact: Cumulative Reduction in Fisheries Productivity~~
~~As described above under Groundwater, the proposed project would not result in direct significant impacts to surface and groundwater resources. However, implementation of the GO in combination with certain environmental conditions and other projects that contribute to nitrate contamination (such as on-going agricultural crop fertilization, feed lots, dairies, and septic systems) has the potential to contribute to groundwater impairment from nitrates, and, under certain environmental conditions, could impair surface water quality. Increases in nitrates in surface water could cause eutrophication and therefore reduced fisheries productivity. However, Mitigation Measure 13-1, described above, would reduce this cumulative impact to a less-than-significant level.~~

## Biological Resources

### Impact: Cumulative Loss of Special-Status Plant and Wildlife Species or the Loss or Disturbance of Biologically Unique or Sensitive Natural Communities

Land application of biosolids would generally occur on lands that have previously been disturbed, such as existing agricultural operations. Some land application of biosolids could occur on lands that are not currently disturbed, such as the conversion of range land to more land intensive agricultural operations. In these cases, land application could result in the loss of special-status plant and wildlife species or the loss or disturbance of biologically unique or sensitive natural communities. Other past, present, or reasonably foreseeable future projects that involve the conversion of land from open space to other

uses also could result in the loss of special-status plant or wildlife species or the disturbance or loss of biologically unique or sensitive natural communities. Refer to Chapter 7, "Biological Resources", for a discussion of impacts and recommended mitigation measures to reduce the effects of the proposed project to a less-than-significant level. If these mitigation measures are implemented, the project's effect on biological resources would be reduced to a minimum and the proposed project would not contribute to a significant cumulative impact.

## Air Quality

### Impact: Cumulative Increase in $NO_x$ and PM10 Emissions

The proposed project could result in an increase in NOx and PM10 emissions resulting from transport of biosolids from POTWs to land-application sites and from the use of farm equipment to spread and incorporate biosolids into the soil during land application operations. Land application of biosolids is expected to increase over the next 15 years as the population increases. Increases in air quality emissions resulting from the project would be greatest in Kern, Kings, Merced, San Diego, Riverside, and Solano Counties, where the greatest amount of land application occurs. Other land development projects, industrial projects, and the increase in air quality emissions resulting from activities associated with population growth would also contribute to an increase in air quality emissions. Air districts in non-attainment regions will be required to implement agriculture control measures to regulate NOx and PM10 under SB 700 (Chapter 479, Statutes of 2003), however, the contents of these requirements are not yet known (California Legislation 2003). Air quality management plans (AQMPs) include policies to reduce air emissions from industrial operations, auto and truck exhaust, increases in population, and other activities that could result in increased air emissions. This cumulative impact is considered less than significant because AQMPs include policies aimed at reducing vehicle emissions (such as those that would be generated by implementation of the GO) and direct air quality impacts would be reduced to a less-than-significant level with implementation of Mitigation Measures 10-1 and 10-2.

## Transportation

### Impact: Cumulative Deterioration of Roadways

Implementation of the GO would result in an increase in trips on roadways, some of which are currently deteriorated, for the delivery of biosolids to land application sites. As described in Chapter 9, "Traffic", this direct impact is considered less than significant. However, this cumulative impact is considered less than significant because the number of vehicles that use these roads for the delivery of biosolids is a small percentage of the overall volume of vehicles using these roads. Additionally, some counties have roadway management plans that include policies to repair deteriorated roadways and roadway impact fees to pay for roadway repairs.

# Chapter 14. Alternatives Analysis

# Chapter 14. Alternatives Analysis

This chapter has been revised since the Biosolids PEIR was first circulated for public review and comment. In response to litigation over the PEIR, this chapter now analyzes two additional alternatives to the proposed Biosolids General Order that were not previously discussed:

- Class A Only; and
- Restriction on Application to Food Crops.

These are in addition to the following three alternatives analyzed in the prior Biosolids PEIR:

- No-Project;
- Modified General Order Provisions and Specifications; and
- Land Application Ban.

No substantive change is being made to the discussions of the three original alternatives.

The prior Biosolids PEIR identified a number of other alternatives that had been considered during the scoping process, but rejected from further analysis. The "Class A Only" and "Food Crop Limitation" alternatives are now being analyzed at the same level of detail as the No-Project, Modified GO, and Land Application Ban alternatives. The additional alternatives are similar to the "in vessel composting" and "crop limitation" alternatives that were previously on the list of Alternatives Considered but Rejected. Those two alternatives have been removed from the rejected list. Otherwise the discussion of rejected alternatives is unchanged.

Consistent with the rest of the EIR, this chapter uses "biosolids" to refer to treated sewage sludge that complies with the requirements of 40CFR 503. Biosolids can either be disposed of through alternatives such as incineration, landfills, or dedicated land disposal sites; or the biosolids can be beneficially used for agricultural land application or horticultural mixes for the nutrients and organic content it has. Thus, the terms disposal and beneficial use are used in this chapter for distinct purposes.

# Alternatives to the Issuance of the General Order

In accordance with Section 15126.6 of the State CEQA Guidelines, a draft ~~program~~ EIR must describe a reasonable range of alternatives to the proposed project that could feasibly enable the project's basic objectives to be met while reducing or eliminating any of the significant adverse impacts of the proposed project. As detailed in Chapter 2, "Program Description", the objectives of this project are to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on NOIs filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids disposal program for land application operations at the regional level and contains requirements that are based on sound science and best professional judgment.

In this chapter, alternatives to the proposed project are described and the anticipated environmental impacts of the alternatives are compared with those analyzed for the proposed GO in Chapters 3-12 of this report. The alternatives analyzed in this chapter are described below.

## No-Project Alternative

Under the No-Project Alternative, it is assumed that land application of biosolids would continue in its current form and be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations. Existing land application operations would continue and would be controlled by the conditions contained in their individual permits. Biosolids generation would continue to increase as described in Chapter 2, and the amount of material going to land application sites would increase proportionately. The types of conditions and prohibitions placed on existing and new land application operations would be similar to those imposed in existing permits from the RWQCBs. Because it is not possible to predict how county and city

governments might alter their regulation of land application of biosolids in the future if a statewide GO were not in place, it is assumed that local regulation would remain in its current form.

The objectives of the proposed project would not be met under this alternative. There would be no statewide, unified approach to regulation of land application with a streamlined permit review and CEQA documentation process. Decisions on use of the federal Part 503 regulations and levels of environmental protection would be made on an individual-project basis by the RWQCBs.

## Modified GO Provisions and Specifications Alternative

Land application of biosolids, as allowed under the proposed GO, has the potential to result in several significant impacts. To provide for addressing these impacts while still meeting the objectives of the proposed project, an alternative was developed that incorporates the mitigation measures identified in Table ES-1 that are necessary to address potentially significant effects as modified provisions and specifications. These added provisions and specifications would be as follows:

- Dischargers shall provide sufficient information in their Pre-Application Reports to determine the potential for soil degradation or reduced land productivity and shall ascertain, or use the services of a qualified soil scientist or qualified agronomist to ascertain, that no such soil degradation or reduced land productivity will occur as a result of biosolids application.

- After an application of Class B biosolids, the discharger shall ensure that animals are not grazed on that land for at least 90 days.

- Prior to application of biosolids to agricultural land, the discharger shall enter site assessor parcel numbers into a statewide tracking system, accessible to the public, that can identify whether a parcel of land has received an application of biosolids.

- Land application of Class B biosolids shall be prohibited, under the GO, within ½ mile of areas defined as having a “high potential for public exposure”.

- Dischargers shall ensure that biosolids transporters develop truck routing plans that avoid traffic in primarily residential neighborhoods.

- All biosolids shall be transported in trucks that have been adequately cleaned to remove biosolids from the exterior of the vehicles prior to leaving the site of generation and the site of land application.

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed, or lands left fallow for more than 1 year without a site assessment being conducted for special-status plant and wildlife species or biologically unique or sensitive natural areas.

- There shall be no discharge of biosolids within 500 feet of enclosed water bodies potentially occupied by desert pupfish.

- The transport of biosolids shall not generate daily emissions of nitrogen oxides or particulate matter in excess of daily thresholds included in the policies of California air districts responsible for achieving attainment status under the federal and state Clean Air Acts.

- Dischargers shall control fugitive dust on unpaved access roads to land application sites.

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed without a cultural resources investigation being conducted, and if significant resources are found, development of a mitigation plan.

All other elements of the proposed GO are assumed to remain as described in Chapter 2 of this EIR.

## Land Application Ban Alternative

Under this alternative, land application of biosolids would not be facilitated by regulation. Regulation of land application for agricultural, horticultural, silvicultural, or land reclamation purposes would be sufficiently restrictive to make the activity economically uncompetitive. Biosolids generators would be encouraged to pursue other options, such as use of landfills, incineration, and development of dedicated disposal sites (monofills). Each of these disposal options was mentioned in the scoping process. It is assumed that this policy approach would result in an effective ban on land application for beneficial reuse. Although this alternative does not meet the objectives of the proposed GO, it does reflect numerous comments received from the public during the scoping process requesting that the SWRCB consider biosolids disposal options rather than land application for beneficial reuse. This alternative is not considered the environmentally

superior alternative to the GO because it is not within the reasonable range of alternatives and it does not meet the project objectives.

This alternative would differ from the No-Project Alternative in that the current process of issuing individual WDRs through the RWQCBs (which is assumed under the No-Project Alternative) would be discouraged in favor of pursuit of ~~disposal~~other options. As stated above, individual WDRs would be discouraged through restrictive policies and permitting requirements.

Assuming that biosolids generation continues to increase as described in Chapter 2, the need for landfill space, new dedicated landfills (monofills), and incineration facilities are expected to increase. Biosolids treatment levels would be modified to meet the requirements for these disposal methods. The material would be transported by truck to the disposal facilities and it would be managed and disposed of according to current practice in the state.

## Class A Only Alternative

This alternative would allow the application of only Class A biosolids to land. The proposed General Order would cover the beneficial use of Class A, Exceptional Quality, and Class B biosolids. Under the Class A Only Alternative, the GO would exclude the land application of Class B biosolids.

In addition to restricting land application to Class A biosolids, the alternative would incorporate a number of non-pathogen-related measures that are also included in the Modified GO Alternative:

- Dischargers shall provide sufficient information in their Pre-Application Reports to determine the potential for soil degradation or reduced land productivity and shall ascertain, or use the services of a qualified soil scientist or qualified agronomist to ascertain, that no such soil degradation or reduced land productivity will occur as a result of biosolids application.

- After an application of Class A biosolids, the discharger shall ensure that animals are not grazed on that land for at least 90 days to allow for SOC degradation.

- Land application of Class A biosolids shall be prohibited within ½ mile of areas defined as having "a high potential for public exposure."

- Dischargers shall be required to ensure that any biosolids adhering to the outside of the biosolids transport trucks and tires be removed before the trucks leaving the dischargers' sites or application areas.

- The Pre-Application Report shall be revised to include a location for the discharger to indicate whether the land application site contains natural terrestrial habitat areas or whether it has been fallow for more than 1 year. The discharger shall be required to submit a report that states whether special-status species occur on the site. If special-status species occur on the site, the report must identify the measures that will be taken to mitigate or avoid impacts on these species. The report must be prepared by a qualified biologist.

- The Pre-Application Report shall be revised to include a location for the discharger to indicate whether the land application site contains biologically unique or sensitive natural communities. If the application site contains these habitats, the discharger must submit a biological report with the Pre-Application Report that indicates measures to mitigate or avoid impacts on these habitats. The report must be prepared by a qualified biologist.

- Proposed land applications in the habitat range of the pupfish shall be reviewed for proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet shall be required.

- The transport of biosolids will not be allowed to generate daily emissions of nitrogen oxides or particulate matter in excess of daily thresholds included in the policies of the California air districts responsible for achieving attainment status under the federal and state Clean Air Acts.

- Dischargers shall control fugitive dust on unpaved access roads to land application sites.

- Dischargers shall ensure that biosolids transporters develop truck routing plans that avoid traffic primarily residential neighborhoods. If the use of haul routes near residential land uses cannot be avoided, the project applicant or transporter will limit project-related truck traffic to daylight hours (8 a.m. to 6 p.m.).

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed without a cultural resources investigation being conducted, including but not limited to a records search at the appropriate Information Center, and, if significant resources are found, development and implementation of a mitigation plan.

- If human remains are discovered, the discharger shall comply with state laws relating to notification of the County Coroner and the disposition of Native American burials, if any are found.

- As a condition of the review of each individual NOI submitted for a proposed biosolids application, the RWQCB engineer responsible for issuing the NOA would evaluate whether the discharge would occur in an area designated as having existing nitrate contamination problems and evaluate whether the proposed discharges would pose an imminent threat of contributing to or causing exceedences of water quality standards for nitrates. If the engineer finds either condition, the RWQCB shall minimize the potential water quality impacts by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the discharge would not cause or contribute to violations of water quality standards.

- The SWRCB will continue to identify causes of cumulative nitrate loading in nitrate sensitive areas and develop an effective strategy for reducing those sources.

Under the regulations established by the federal Environmental Protection Agency (EPA), biosolids must be demonstrated to meet three separate criteria to be land applied. These include:

- **Pathogens** - where the biosolids can meet one of two pathogen reduction requirements, Class A biosolids are treated sufficiently for the level of pathogens to be substantially reduced but not completely removed, or Class B biosolids, where detectable levels of pathogens remain, but EPA has determined that restrictions on their use and the sites where they are applied provide equal protection,

- **Vector Attraction Reduction** - where the biosolids must meet at least one of ten specific procedures or tests to reduce or prevent vectors such as flies and rodents from being attracted to the biosolids, and

- **Pollutant Concentration Limits** - where the biosolids must be tested and the application sites must either be monitored or, if the metals concentrations within the biosolids are low enough, the EPA has determined no monitoring is necessary.

Exceptional Quality (EQ) biosolids are biosolids that meet Class A requirements, strict vector attraction requirements, and meet the lowest metals content requirements. of any biosolid (40 CFR 503.13 and 40 CFR 503.32) . When a biosolid meets EQ standards, there are no EPA restrictions to use and the application site is not required to be

monitored for toxic metals concentration. EQ biosolids are commonly sold by the bag and marketed for home, rather than commercial agricultural, use. In contrast, while Class A biosolids have no site restrictions, they are subject to monitoring to avoid the concentration of toxic metals over time.

"Class A" can be described as a family of treated biosolids, rather than a single type. Appendix H provides more information on the technologies that produce Class A biosolids. Briefly, Class A biosolids may be treated through a variety of methods to comply with Class A pathogen reduction requirements. Class A biosolids may range from dry to liquid in form.

In comparison to Class B biosolids, Class A has reduced nitrogen content. This in turn reduces its effectiveness as a soil amendment.

This alternative meets the GO program objectives of providing for the beneficial use of biosolids, and providing a regulatory framework for biosolids application to land. It would be subject to the limitations on application set out in federal regulations, including avoidance of cumulative concentrations of metals. Class A biosolids meet the same standards for metal content as Class B biosolids. The overall volume of biosolids that might be expected to be beneficially applied would be less than that expected under the proposed GO because there is less capacity to treat biosolids to meet Class A standards than there is to meet both Class A and Class B standards.

Restricting the land application of biosolids to Class A will limit the most common current approach to beneficial use. As discussed in Chapter 2, approximately 48% of the total dry tons of biosolids produced in 2001 were land applied. Most of this volume consisted of Class B biosolids.

Under the Class A Only Alternative, sanitation agencies would have to increase the amount of biosolids being treated to meet Class A standards, haul Class B biosolids to other states for land application, or dispose of the biosolids in landfills or through incineration. The particular approach chosen by agencies will be driven by a number of physical and economic factors. These include the availability of space in landfills, the potential for increased use of biosolids as landfill alternative daily cover, the feasibility of Class A treatment at existing facilities, costs of alternative treatment, transportation costs, and landfill fees, and availability of out-of-state application sites.

In response to phased bans on Class B biosolids application in Fresno, Kern, Kings, Riverside, and Tulare counties, a number of sanitation agencies have been studying alternative management practices which would treat biosolids to meet the Class A or Exceptional Quality standard. The following types of treatment technologies are a representative sample of the approaches being considered by several agencies:

- Thermophilic anaerobic digestion
- Heat drying
- Chemical addition
- In-vessel composting

Another response to the county bans has been to find alternative locations for the land application of biosolids. As application sites have become less available in California, some sanitation agencies have increased their shipments of Class B biosolids to Arizona and Nevada for beneficial reuse on agricultural lands in those states. Treating biosolids to Class A standards does not necessarily make them acceptable in all counties that restrict Class B biosolids. As examples, Riverside County would not allow the application of odiferous Class A biosolids (Class A treatment does not necessarily remove odors), and Kings County will allow only Exceptional Quality compost 2006.

## Possible Treatment Technologies

These represent a range of treatment approaches and markets that could be selected by sanitation agencies under the Class A Only Alternative. This is not intended to be a comprehensive listing of all possible types of treatments, but rather a reasonable sample that describes the actions which may result from the Class A Only Alternative.

The improvements needed for a sanitation agency to undertake one or more of these treatment approaches depends upon the types of treatment and treatment infrastructure that the particular agency is currently employing. Because there is insufficient information about the future use of each of these methods to determine their level of use, a detailed analysis of their effects would be speculative. As a result, the following discusses the general characteristics and impacts of each of the treatment and markets.

**Thermophilic anaerobic digestion.** This process consists of an enclosed tank where the sewage sludge is treated at thermophilic temperatures (i.e., 50 to 62 degrees C) under anaerobic digestion conditions. There are multiple configurations for this process, but they all contain a total of approximately fifteen days of detention time in the presence of anaerobic acid and methane-forming bacteria which treat the solids.

The resultant biosolid meets Class A requirements. The process is more effective than conventional mesophilic (i.e., 35 to 40 degrees C) anaerobic digestion, which does not result in Class A biosolids, though it still produces gas with methane, CO2 and H2S, which can produce odiferous sludge, as would a conventional mesophilic anaerobic digestion process.

**Impacts.** Conversion of existing digester facilities to make them capable of thermophilic anaerobic digestion would result in construction-related impacts.

Necessary construction may include installation of new equipment at existing digesters and construction of new digesters at existing treatment plants. Construction of the necessary facilities would result in increased levels of noise and traffic during the construction period.

One operational impact will be an increased demand for energy to fuel the additional heating required by this process. The amount of energy needed beyond current demand will depend in part on the ability to reuse methane gas generated during the digestion process. Typically, the high-quality methane produced by the thermophilic digesters could be used to meet a portion of the fuel needs of the process. Any burning of waste gases would be subject to permitting by the pertinent air quality management or air pollution control district.

The significance of potential impacts would be examined in the environmental analyses prepared for future conversions to the modified processes. Because the installations would likely occur at existing facilities and would be subject to permitting from city and county governments, as well as the pertinent air district, the impacts are generally expected to be less-than-significant.

**Heat drying.** This is a generic term for any of several methods for heating biosolids to kill viable pathogens and to reduce their moisture content to 10% or lower. This requirement is reached by agitating biosolids while exposing them to heat using hot gases such as hot air or steam, or heated surfaces to increase the evaporation rate and temperature. Common approaches include rotary drum dryers and disk/paddle dryers. Rotary drum dryers resemble cylindrical kilns that mix the biosolids. The drying gas is largely reheated and recycled as part of the process (typically, about 10 percent of the gas is treated and either released into the atmosphere or used as combustion air). Disk/paddle dryers use heated disks or paddles to mix the biosolids. The disks or paddles are heated by a heat transfer medium such as steam, water, or oil. (Delta Diablo Sanitation District 2002).

The resultant product meets Class A requirements. Typically, a heat drying process would require new equipment, and a building to enclose the equipment, to be installed at the wastewater treatment facility. This may include equipment necessary to produce dry pellets as the final product.

**Impacts.** Installing heat drying equipment at existing treatment facilities would result in construction-related impacts. Construction of the necessary facilities would result in increased levels of noise and traffic during the construction period.

One operational impact will be an increased demand for energy to fuel the additional heating required by this process. Air drying techniques, which require direct heating and exchanging air through the drier, are generally more energy intensive than disk/paddle dryers which use indirect heat. The amount of additional energy needed beyond current demand will depend in part on the ability to reuse methane gas generated during the digestion process. Any burning of waste gases and the exhaust gases from the heating and drying process would be subject to permitting by the pertinent air quality management or air pollution control district. These potential impacts have precluded several agencies from implementing heat dryers at their facilities.

One positive impact is that the weight and volume of the biosolids hauled from the treatment plant would be reduced to a quarter of the "dewatered" biosolids amount. This significantly reduces the number of truck loads hauled from the site and subsequent vehicle emissions and traffic disruption.

The significance of potential impacts would be examined in the environmental analyses prepared for future installations of heat dryer systems. Because the installations would likely occur at existing facilities and would be subject to permitting from city and county governments, as well as the pertinent air district, the impacts are generally expected to be less-than-significant.

**Chemical addition.** Chemical addition is a term for any of several commercial processes by which a chemical, usually lime (CaO), is added to biosolids to kill viable pathogens by increasing the pH (making it more alkaline). Typically, following anaerobic digestion, the biosolids would be dewatered, then conveyed to a vessel where it would be thoroughly mixed with chemicals. The biosolids/chemical mixture would then be allowed to cure, during which an exothermic reaction within the mixture, and in some processes additional heat, would pasteurize the mixture. The heat would further reduce the water content of the biosolids. The biosolids would then be further dried either by windrow drying, or by some contained heating process such as a rotary heat dryer. (Delta Diablo Sanitation District 2002). Drying may occur on- or off-site.

Chemical addition results in a Class A biosolids that is dry and granular. It is often alkaline, so in the eastern U.S. it is used to adjust the pH of acidic soils. However, such soils are rare in California, so the practical use of this biosolids product may be limited.

**Impacts**. Installing chemical addition equipment at existing treatment facilities would result in construction-related impacts. Construction of the necessary facilities would result in increased levels of noise and traffic during the construction period.

Operational impacts could include an increased demand for energy if the selected process requires additional heating. The amount of additional energy needed beyond current

demand will depend in part on the particular process. Some commercial processes rely on the heat created by the exothermic reaction of the biosolids and chemicals. Others require additional heat or pressure to be added to the reactor vessel because the reaction does not reach the necessary temperatures by itself. There is insufficient information available at the level of detail contained in the GO to make a definitive determination of the significance of operational energy impacts.

Lime is usually produced from the heating of limestone, or may be the form of power plant ash (when metal levels are acceptable) or concrete dust. Increased hauling of lime into and out of the site where it is chemically stabilized would increase traffic and related air quality emissions over current levels.

The significance of potential impacts would be examined in the environmental analyses prepared for future installations of chemical addition systems. Because the installations would likely occur at existing facilities and would be subject to permitting from city and county governments, as well as the pertinent air quality or air pollution district if there are air emissions, the impacts are generally expected to be less-than-significant.

**In-Vessel Composting.** In this process, dewatered biosolids are typically mixed with a bulking agent such as sawdust, woodchips, or chipped green waste and placed in a reactor vessel within which aerobic conditions are maintained (some processes use biosolids as the bulking agent). This encourages microbial decomposition of the biosolids over a period of 14 to 21 days. The high temperatures that result from the microbial decomposition process reduce pathogens to Class A standards. After removal from the reactor vessel, the biosolids are typically given an additional curing period of approximately 30 days, although some commercial processes are efficient enough to result in a finished product at the end of the in-vessel stage. Curing occurs in a warehouse equipped with air scrubbers to treat gas and control odors. The size of in-vessel composting facilities can vary substantially.

The product that results from this process meets Class A requirements, is rich in organic matter, has a near neutral pH, and has a moisture content of 50% or less. (City of Santa Barbara, 2001). This process takes substantially less space than the traditional windrow or aerated static pile composting, making it a potential option for installation at existing treatment facilities where room allows. (Delta Diablo Sanitation District 2002).

**Impacts.** Installing in-vessel composting equipment at existing treatment facilities would result in construction-related impacts. This would also be true should size constraints necessitate off-site construction. Construction of the necessary facilities would result in increased levels of noise and traffic during the construction period.

Composting facilities would involve a change in truck traffic over current operations. Trucks would be used to deliver bulking agents, as well as for transportation of the processed compost. This would increase the level of truck traffic at individual POTWs.

Operational impacts could include odors; however, this is unlikely if the facility is operated correctly. In-vessel composting does not require substantial heating, but the air movement necessary to maintain optimum microbial action consumes additional energy in comparison to Class B techniques. In addition, continuous air exchange is necessary (air is filtered during exchange) to maintain a safe work environment.

The significance of potential impacts would be examined in the environmental analyses prepared for future installations of in-vessel composting systems. Because the installations would likely occur at existing facilities and would be subject to permitting from city and county governments, as well as the pertinent air quality or air pollution district if there are air emissions, the impacts are generally expected to be less-than-significant.

## Energy Consumption

As part of a legal deposition in 1999, Robert Gillette, P.E., D.E.E of Carollo Engineers prepared an estimate of the energy needs of converting Class B biosolids to Class A standard using three of the alternative technologies described above: heat drying, chemical treatment, and in-vessel composting. While actual energy use will vary dependent upon the specific methods employed, this estimate nonetheless offers a general indication of the level of energy consumption that would be involved. The following table is based on the overall energy consumption for conversion of 600,000 wet tons (low) and 1,000,000 wet tons (high) of Class B biosolids to Class A biosolids. This is more biosolids than produced by any single facility or agency, and would represent the combined yearly energy use of several sanitation agencies.

## Table 14-1. Conversion of Class B Biosolids to Class A

| Technology | Electrical Power MWHs | Fuel Gallons | Natural Gas BTUs (millions) |
|---|---|---|---|
| Heat Drying | 53,000 (high)<br>32,000 (low) | N/A | 3.24 (high)<br>1.94 (low) |
| Chemical Treatment | 60,000 (high)<br>36,000 (low) | N/A | 2.80 (high)<br>1.68 (low) |
| In-Vessel Composting | 100,000 (high)<br>42,000 (low) | 533,000 (high)<br>160,000 (low) | N/A |

(Gillette 1999)

At 1999 rates of consumption, this approximates the annual electricity demand of 5,000 and 15,000 typical Southern California homes, and the annual natural gas demand of between 10,000 and 18,000 typical homes.

## Food Crop Limitation Alternative

Under this alternative, the GO would prohibit the application of all biosolids on lands where food crops are to be grown. The Food Crop Limitation Alternative would invoke a state standard that is stricter than federal regulations by prohibiting the application of Class A, Class B, and Exceptional Quality biosolids to lands where food crops are grown. The term "food crops" should be the same as used in federal regulations. The Part 503 regulations define food crops as follows:

*"Food crops are crops consumed by humans. These include, but are not limited to, fruits, vegetables, and tobacco." (40 CFR 503.9(l))*

There are many possible ways to implement a ban on biosolids application to lands where food crops are grown.

First, the definition of food crops is subjective. In addition to the Part 503 definition of food crops. EPA has provided guidance in several documents (EPA/831-B-93-002b) - Land Application of Sewage Sludge, and EPA/625/R-92/013 - Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge) that feed crops such as grains, grasses, and silage fed to cattle are not “food crops.” In fact, some fiber crops which are not considered to be food crops, like cotton, have elements which may be processed for food (i.e., cottonseed oil).

Second, the ban on land application of biosolids to lands where food crops are grown could be implemented in perpetuity or for a specific time period, just as the current Part 503 regulations prohibited harvesting of food crops that are grown beneath the ground surface until 38 months after Class B biosolids are land applied. One complication to this is that some tree crops, such as citrus and olives, are long lived and could continue to produce for forty of fifty years after implementation of a General Order. At least some of the citrus orchards have had biosolids applied to them in the past. A permanent ban on crops where biosolids has been applied would place a severe financial burden on these farmers.

Third, it should be understood that EQ biosolids in the form of compost and heat dried pellets are currently marketed through home improvement stores and nurseries and used in home garden throughout California. The regulation of small bagged quantities of EQ biosolids has not been included in the General Order.
In order to compare this alternative to the original General Order, the specifics of implementation must be selected. The selected alternative and the rational for that selection follow.

Under this alternative, the application of biosolids to land would be prohibited where the land is being or will be cultivated for fruits and vegetables. Two sub-alternatives are considered for land that is cultivated for food crops: (a) a full ban on biosolids in perpetuity; and (b) a ban for a period of at least 38 months prior to harvest.

In addition to restricting land application on food crops, the alternative would incorporate a number of non-pathogen-related measures that are also included in the Modified GO Alternative:

- Dischargers shall provide sufficient information in their WDR Pre-Application Reports to determine the potential for soil degradation or reduced land productivity and shall ascertain, or use the services of a qualified soil scientist or qualified agronomist to ascertain, that no such soil degradation or reduced land productivity will occur as a result of biosolids application.

- Land application of biosolids shall be prohibited within ½ mile of areas defined as having "a high potential for public exposure."

- Dischargers shall be required to ensure that any biosolids adhering to the outside of the biosolids transport trucks and tires be removed before the trucks leaving the dischargers' sites or application areas.

- The WDR Pre-Application Report shall be revised to include a location for the discharger to indicate whether the land application site contains natural terrestrial habitat areas or whether it has been fallow for more than 1 year. The discharger shall be required to submit a report that states whether special-status species occur on the site. If special-status species occur on the site, the report must identify the measures that will be taken to mitigate or avoid impacts on these species. The report must be prepared by a qualified biologist.

- The WDR Pre-Application Report shall be revised to include a location for the discharger to indicate whether the land application site contains biologically unique or sensitive natural communities. If the application site contains these habitats, the discharger must submit a biological report with the Pre-Application

Report that indicates measures to mitigate or avoid impacts on these habitats. The report must be prepared by a qualified biologist.

- Proposed land applications in the habitat range of the pupfish shall be reviewed for proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet shall be required.

- The transport of biosolids will not be allowed to generate daily emissions of nitrogen oxides or particulate matter in excess of daily thresholds included in the policies of the California air districts responsible for achieving attainment status under the federal and state Clean Air Acts.

- Dischargers shall control fugitive dust on unpaved access roads to land application sites.

- Dischargers shall ensure that biosolids transporters develop truck routing plans that avoid traffic primarily residential neighborhoods. If the use of haul routes near residential land uses cannot be avoided, the project applicant or transporter will limit project-related truck traffic to daylight hours (8 a.m. to 6 p.m.).

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed without a cultural resources investigation being conducted, including but not limited to a records search at the appropriate Information Center, and, if significant resources are found, development and implementation of a mitigation plan.

- If human remains are discovered, the discharger shall comply with state laws relating to notification of the County Coroner and the disposition of Native American burials, if any are found.

- As a condition of the review of each individual NOI submitted for a proposed biosolids application, the RWQCB engineer responsible for issuing the NOA would evaluate whether the discharge would occur in an area designated as having existing nitrate contamination problems and evaluate whether the proposed discharges would pose an imminent threat of contributing to or causing exceedences of water quality standards for nitrates. If the engineer finds either condition, the RWQCB shall minimize the potential water quality impacts by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the discharge would not cause or contribute to violations of water quality standards.

- **g** The SWRCB will continue to identify causes of cumulative nitrate loading in nitrate sensitive areas and develop an effective strategy for reducing those sources.

The Food Crop Limitation Alternative meets the GO program objectives of providing for the beneficial use of biosolids, and providing a regulatory framework for biosolids application to land. Applications to land would otherwise be in accordance with federal requirements, including restrictions on the cumulative build-up of metals.

Sub-alternative (b), the 38-month transition period, is based on the more conservative of the following two periods established by federal law. The National Organic Program (7 CFR 205) regulates the labeling, marketing, and production of foods that are to be identified as "100 percent organic," "organic," or "made with organic." Section 205.105 prohibits the use of "sewage sludge" (the term adopted by this regulation for biosolids) in the production of organic foods. Any field or farm parcel from which harvested crops are intended to be sold, labeled, or represented as organic must have had no biosolids applied to it for a period of 3 years (e.g., 36 months) immediately preceding harvest of the crop (7 CFR 205.202).

The EPA Part 503 Biosolids Rule (40 CFR 503) provides a variety of restrictions on the harvesting of crops where Class B biosolids are applied. The most restrictive of these is for food crops with harvested parts below the land surface where biosolids remain on the land surface for less than 4 months prior to incorporation into the soil. In that case, food crops may not be harvested for 38 months after the application of biosolids (40 CFR 503.32[b][5]).

Note that sub-alternative (b) would be more restrictive than federal limitations on food crop application because it would apply a time restriction to Class A and Exceptional Quality biosolids that federal regulations do not. In addition, it would apply to all food crops, not just those grown below the ground surface. The GO established under the Food Crop Limitation Alternative would also be more restrictive than the Kern and Kings County ordinances, which allow the application of Exceptional Quality and composted biosolids, respectively, to food crops with RWQCB permits.

Food Crop Limitation Alternative would continue to allow biosolids to be applied to non-food crops such as cotton, alfalfa, and pasture land, and cover crops such as small grains not grown for harvest.

According to information gathered by the U.S. EPA in 2001, food crops make up a major portion of the agricultural land to which biosolids are being applied in California (U.S. EPA 2003). Based on U.S. EPA reporting data, biosolids were applied to a total of approximately 133,000 acres of agricultural land in 2001. This included approximately 13 acres of pumpkins, 38 acres of walnuts, 560 acres of safflower, and 57,590 acres of

wheat and corn (this does not include corn used for silage). Therefore, during that period, food crops made up approximately 44% of the agricultural land to which biosolids were applied.

This total of food crop acreage is probably overstated. Wheat acreage makes up the majority of this land. However, not all wheat grown in California is used for human consumption. Wheat can also be used as a feed grain. The Part 503 regulations are not clear whether wheat is always considered a "food crop," and there is no way to disaggregate the acres of wheat used for human food from those used for animal feed from the data available. So, for purposes of a conservative estimate, this analysis assumes that all of the wheat is being used for human consumption.

Under this alternative, the volume of Class B biosolids that could be applied to agricultural land would be substantially reduced. As a result, a major method of using biosolids would be eliminated and alternative means of dealing with nearly half of the production of biosolids would need to be found.

Under either sub-alternative (a) or (b), farmers who currently accept biosolids for use on non-food crops may be disinclined to continue to do so because the alternative would restrict their future use of the land for food crops. Where biosolids are currently applied to food crops, farmers would have to go back to chemical fertilizers and soil amendments under sub-alternative (a) and would likely to go back to such prior practices under sub-alternative (b). Because biosolids are often supplied farmers for free, and chemical fertilizers and amendments are not, this alternative would result in an undetermined economic impact on farmers. Further, biosolids provide all or a portion of the fertilizer needs of the fields to which they are applied. Therefore, reduction in their use would result in an increase in the use of chemical fertilizer products, with a resultant potential increase in release of nitrogen to the environment due to chemical fertilizers' greater nitrogen concentration..

This analysis of the Food Crop Limitation Alternative (b) assumes that the limitation, including the time delay between application of biosolids and the use of the land for food crops, would be a strong disincentive for the use of biosolids on food crops. While it would not technically constitute a total ban, it would probably dissuade many farmers from applying biosolids to food crops. The 38-month restriction would limit farmers' ability to meet shorter-term market demands by increasing food crop acreage. The restriction would require that the land either lay fallow or be planted in a non-food crop during the 38-month transition period, and effectively limit the production of food crops on treated fields to 3 years of every 10.

Although there are a number of possible outcomes resulting from eliminating a current beneficial use of biosolids, the following are considered to be a reasonable set of scenarios for biosolids producers in making up the difference:

- Expansion of the home market for biosolids
- Dedication of land for surface disposal of biosolids
- Disposal of biosolids in landfills/use as alternative daily cover
- Transport of biosolids to other states for land application

The following discusses these representative approaches in more detail.

**Expansion of the Home Market.** Pursuant to Federal Part 503 regulations, Exceptional Quality biosolids can be and are being sold as soil amendments to home gardeners. Typically, they are bagged and sold through gardening or home improvement stores. This currently accounts for a very small amount of the biosolids being produced in California. Because of the cost of converting existing treatment facilities to produce Exceptional Quality biosolids, costs related to marketing, and the limits on prices that can be competitively charged for packaged biosolids, this is not expected to expand substantially. Because the Food Crop Limitation Alternative would also preclude the beneficial use of Class A and Exceptional Quality biosolids, there would be little or no incentive to treat biosolids to Class A or Exceptional Quality standards other than for the home market.

**Impacts.** The impacts discussed under Class A Only Alternative would result if Exceptional Quality biosolids treatment were increased over current levels in order to serve an expanded home market. In addition, all of the EQ biosolids have to be bagged and transported to markets for sale. No other impacts are considered significant. The U.S. EPA allows the use of Exceptional Quality biosolids for home gardens without restriction. Therefore, an increase in home use would have a less-than-significant impact.

**Dedication of land for surface disposal.** Another possibility is that agricultural lands would be converted to surface disposal facilities for biosolids. Such facilities are intended for the final disposal, rather than the beneficial use or recycling of biosolids and, as a result, biosolids are applied at much higher rates than they would be when applied to agricultural lands. Surface disposal facilities are subject to permitting under the U.S. EPA (Subpart C, Part 503 rule), as well as state (CIWMB and RWQCB) and local permitting (conditional use permit). The permitting process can be expected to be multi-layered and intensive. While this would tend to discourage a farmer from converting a portion of their farm to a surface disposal site, this may nonetheless offer a business opportunity for companies that would specialize in operating such facilities. Although it is a possibility, this approach is unlikely to become a substantial method of disposal because of the cost to sanitation agencies of transportation from treatment

facilities and disposal fees. With the exception of a facility operated by the Sacramento Regional County Sanitation District, the Dublin San Ramon Sewer District, the Las Gallinas Valley Sanitation District and the Novato Sanitation District next to their treatment facilities for its own use, there are no such facilities in California.

East Bay Municipal Utilities District (EBMUD) commissioned a technical study of alternative disposal methods in 2003, which offers an example of typical costs. The study estimated that a 100-acre surface disposal facility to serve its needs would cost EBMUD approximately $36.65 million to plan, permit, and construct and approximately $1.33 million annually to operate and maintain. (East Bay Municipal Utilities District 2003) .

**Impacts.** The impacts related to the development of surface disposal facilities would be based on the characteristics of the site proposed for such facilities. Because neither the number, nor location of such future facilities can be known (or even whether they would all be within California), an attempt to describe the level of significance of specific impacts would be purely speculative. However, general impacts would be expected to include increased truck traffic and related air quality emissions, noise, and odors. Any of those may be significant. Due to the multi-jurisdictional permitting process that would be expected to apply to such facilities, water quality or health impacts would be expected to be major regulatory focuses, however, they would be expected to be less-than-significant, as regulated.

**Landfilling/Alternative Daily Cover Use.** In 2000, approximately 10% of the biosolids produced in California was buried in landfills and approximately 20% was used for landfill cover. The California Integrated Waste Management Board (CIWMB) regulates landfill operations in California. Standard landfill operations require active landfill cells to be covered by a minimum of 6 inches of compacted earthen material on at least a daily basis (27 CCR 20680). This is called "daily cover." Biosolids buried in landfills are simply treated as solid waste; biosolids used for landfill cover are used in landfill operations which is considered beneficial use. CIWMB regulations allow the use of biosolids as a compacted, alternative daily cover material provided that (1) the biosolids meet the performance standards for cover material, (2) they do not exceed 25 percent of the total landfill cover material, and (3) public contact with the biosolids is prohibited (27 CCR 20690). Class A and Class B biosolids may be used alone or blended with soil, processed green material, or stabilization agents (i.e., lime, lime kiln dust, or cement kiln dust) as alternative daily cover material (27 CCR 20690).

There are approximately 161 landfills in operation within California (CIWMB 2003a). Of these, approximately 60 are permitted to accept biosolids (CIWMB 2003a). However, anecdotal evidence indicates that the number of landfills accepting biosolids is less than the number permitted to accept biosolids. For example, only 1 of the 6 landfills in Orange County permitted for biosolids disposal actually accepts biosolids and 4 of the

16 southern California landfills permitted to accept biosolids have available capacity (Baroldi Pers. Comm; Tetra Tech 2003). Landfill capacity is available in southwestern Arizona, but would require a longer truck trip (Tetra Tech. 2003).

The landfilling of biosolids is costly for biosolids producers in that it requires the transportation of biosolids to landfills and the payment of tipping fees. The number of landfills accepting biosolids in proximity to urban areas is very limited, so transportation costs would be substantial. Landfilling of biosolids would be unlikely to increase substantially as a result of the Food Crop Limitation Alternative because of these limiting costs.

Biosolids are being applied as alternative daily cover in only 15 of the state's landfills (CIWMB 2003b). Because biosolids are limited to 25 percent of the daily cover, and only a small number of landfills will accept biosolids for this use, this means of beneficial use is unlikely to increase substantially.

**Impacts.** Traffic and related vehicle emissions would increase along routes to existing landfills. Landfills are subject to permitting by the CIWMB, RWQCB, and local enforcement agencies. Use of biosolids as alternative daily cover material is not expected to substantially change existing operations or impacts at landfills. The impact would be less-than-significant.

**Transport to Other States for Land Application.** In response to recent restrictions on biosolids use in the San Joaquin Valley, southern California sanitation agencies have increased their shipments of Class B biosolids to Arizona and Nevada agricultural lands, including Tribal lands of the Fort Mohave Tribe. Given the volume of Class B biosolids that would be affected by this alternative, transport to other states would be likely to become much more common. However, the long-term availability of out-of-state agricultural lands for use by California agencies is not secure. While Arizona and Nevada cannot ban the interstate transfer of biosolids, local agencies in those states can place restrictions on the use of biosolids from all sources, just as some California counties have done. For example, during the summer of 2003, both La Paz and Mohave Counties in western Arizona adopted ordinances restricting the application of biosolids (La Paz County 2003; Mohave County 2003). As shipments increase, the possibility of such restrictions will also increase.

**Impacts.** Traffic and related vehicle emissions would increase along routes to out-of-state application lands. Long-distance traffic would increase on major highways to Nevada and Arizona. This relocates this traffic and approximately doubles the miles traveled per haul. Overall, including traffic in Nevada and Arizona, the traffic impact would be more severe than the proposed GO. The impact would be less-than-significant. Increased truck traffic through the South Coast and Mojave air

basins would result in increased emissions. The cumulative impact of this approach on air quality would be considerable.

## Alternatives Considered but Rejected

A number of other potential project alternatives were considered through the EIR scoping process but were not selected for detailed evaluation in this EIR. CEQA guidelines Section 15126(d)(2) requires that these alternatives be briefly described and the reasons underlying their rejection be identified. The following alternatives were identified either by the SWRCB or individuals participating in the scoping process but have been rejected as infeasible.

- **Regulation through RWQCB General Orders.** This alternative would accomplish most of the proposed project objectives through issuance of GOs by each of the nine RWQCBs. These GOs might vary slightly from one region to the next, but would streamline the permitting process within each region. The alternative was rejected because it did not reduce any of the potential significant environmental effects of the proposed SWRCB GO.

- **Total Prohibition.** -This alternative would place a total ban on the land application of biosolids in California. It was ~~incorporated into the Land Application Ban Alternative, which is analyzed below~~rejected because it would not meet the project objectives (described in Chapter 2) which commit the SWRCB to adopting rules for the land application of biosolids.

- **Partial Prohibition (No Land Application over Enclosed Groundwater Basins).** This partial prohibition alternative would place lands overlying enclosed groundwater basins in the "exclusion area" category of the GO. The alternative was rejected because it did not reduce any of the potential significant effects of the proposed SWRCB GO. No evidence was found that indicated that enclosed groundwater basins in the state were any more likely to have significant adverse water quality effects than other groundwater basins.

- **Engineered Monofills.** This alternative would direct biosolids to monofills engineered exclusively to receive this material. The impacts of diverting biosolids to disposal sites (including monofills) rather than to land application sites ~~is~~are considered in the Land Application Ban Alternative analyzed below.

- ~~**In-Vessel Composting.** In-vessel composting is a biosolids treatment process that reduces the number of pathogens that remain in the material after other~~

~~more typical treatment processes. This treatment could be used to reduce the potential for health-related impacts resulting from the biosolids transport and spreading operations. The alternative was rejected because it did not reduce any of the potential significant effects of the proposed SWRCB GO.~~

- **Worm Casings.** This alternative would direct biosolids to worm farms to provide a food source for worms. The alternative was rejected as infeasible because there is no evidence that there are adequate worm farming operations in the state to accommodate the volume of biosolids going to land application. Also, it is not clear whether this alternative would reduce or eliminate any of the significant adverse effects of the proposed project.

- **Incineration.** Incineration is a biosolids disposal method used by some POTWs in California. The impacts of using this disposal method are described in the analysis of the Land Application Ban Alternative.

- **Disposal at Atomic Testing Sites.** This alternative assumes that biosolids would be disposed of on lands previously used to test atomic weapons. No specific location for this activity was identified in the scoping comments; most of these sites in the western United States are located in Nevada. Neither the SWRCB nor any of the RWQCBs have jurisdiction to approve or regulate the disposal of biosolids in Nevada; therefore, the alternative was rejected as infeasible.

- **Landfilling.** Landfilling of biosolids is a common practice in some regions of California; the effects of this disposal option are considered in the Land Application Ban Alternative.

- **Limit RWQCB Authority to Issue Waste Discharge Requirements for Land Application.** This alternative was identified during the informal discussion phase of the scoping process. The individual suggesting the alternative did not provide additional detail about the intent of limiting RWQCB authority over land application of biosolids. It is assumed that a narrower range of authority was being suggested, resulting in fewer approvals of land application operations. Because this alternative has not been described in sufficient detail for a meaningful analysis to be conducted and changing the permitting authority for the land application of biosolids would not reduce environmental impacts, it has not been considered in detail in the EIR.

- **Modified GO , Providing More Local Control in Determining Exclusion Areas.** This Modified GO alternative would allow for local citizens to have a greater voice in the location of land application activities by determining what are appropriate exclusion areas on a case-by-case basis. The objective of the

proposed GO is to provide a statewide program under state regulatory control; the exclusion areas have been identified based on existing state laws and plans that identify significant resources that should be protected from certain land use activities. The GO would no longer provide its programmatic function if local decisions on exclusions were made on a case-by-case basis. Local governments have the authority to exclude certain land use practices, including land application of biosolids, through their general planning or ordinance processes. These vehicles would be more effective at serving local interests for exclusions. For these reasons, this alternative was rejected as infeasible.

- **Modified Prohibitions Alternative.** An alternative was proposed during the scoping process that added more prohibitions to the GO. These additional measures included prohibition of storage, staging, and bulk application on lands having the following: less than 60 feet of depth to groundwater; land where the elevation is not at least 3 feet above the 100-year floodplain elevation; areas protected from flooding by levees; areas within the inundation zone of any dam or dam failure; areas within 850 feet of any water well; and any area within 850 feet from surface waters, including creeks, ponds and marshes, water supply ditches, and canals that discharge into surface waters. Although this alternative would have the potential for reducing some of the potential adverse effects of the proposed GO, the alternative was not carried into the EIR for more detailed analysis. A similar modified GO alternative has been developed that addresses each of the potentially significant adverse effects of the proposed GO; it is discussed below. A second modified GO alternative ~~was not deemed necessary~~would be repetitive and redundant.

- ~~**Crop Limitation Alternative.** Several suggestions were made during the scoping process that would limit the types of crops that could be grown on land that has received a biosolids application. It was suggested that fresh fruits and vegetables should not be grown on land application sites; also, it was suggested that only fiber and cover crops be allowed on land application sites. These suggestions were not carried forward into the EIR as an alternative because they~~~~this alternative~~ ~~would not avoid~~~~reduce~~ ~~any significant adverse effect~~~~impacts~~ ~~of the proposed GO that could not be otherwise mitigated. The only impact that these suggestions would address is the potential for a reduction in land productivity resulting from public perceptions of biosolids effects. This potential effect can be mitigated by development of a statewide tracking system of land application sites. With the restrictions contained in the proposed GO, there are no significant adverse public health threats anticipated from biosolids application on lands where any type of agricultural product is being grown~~~~. The proposed GO would not result in any public health impacts related to the consumption of fresh fruits and vegetables~~~~.~~

- **Food Processing Waste Alternative.** An alternative was suggested through the scoping process that would separate food processing waste from other wastes. It is assumed that the individual suggesting this action sought to limit land application to food processing waste only. This food processing waste could be applied to the land without the potential adverse effects of applying human-derived waste products. The alternative was rejected because it does not meet any of the objectives of the proposed project; it does not address the land application of all sewage sludge and other biological solids as required by the state Water Code (Section 13274). The suggestion that human-derived biological solids not be applied to the land has been addressed in this EIR in the Land Application Ban Alternative (discussed on following pages).

# Impact Comparison

## No-Project Alternative

As described above, under this alternative land application of biosolids would probably continue to be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations.

### Soils, Hydrology, and Water Quality

The water quality effects of biosolids land application under current regulation would be greater than those anticipated with implementation of the proposed GO. Current regulatory practice does not place restriction on the use of EQ biosolids, and it does not include the runoff control and setback requirements of the proposed GO. The potential for surface water or groundwater contamination from temporary storage of biosolids is greater under current conditions. In addition, the heavy metals cumulative loading restrictions currently being used (the Part 503 limits) do not account for the heavy metals content of soils before land application. Therefore, the potential for accumulating heavy metals in soil that could eventually affect surface water or groundwater would be greater.

### Land Productivity

This alternative would have a greater potential for impacts on land productivity because the ceiling thresholds of various heavy metals concentrations would be higher for applied

biosolids under the No-Project Alternative. Current use of the Part 503 cumulative heavy-metals limitations does not require the inclusion of background soil levels. Additionally, this alternative does not provide a means to address the cumulative loading of molybdenum, which could result in greater impacts on grazing land productivity. The land application of EQ biosolids would remain unregulated, so long-term disposal operations could eventually affect land productivity through the creation of nutrient imbalances or heavy metals buildup to potentially phytotoxic levels.

## Public Health

The No-Project Alternative has the potential to result in slightly greater impacts on public health because existing provisions designed to prevent groundwater contamination by biosolids (e.g., setbacks, minimum distance to wells, runoff controls, minimum depth to groundwater) are not as stringent as those included in the proposed GO. The RWQCBs could adopt stricter controls to protect public health in the future, but current practice does not include all of the controls mentioned above. In addition, current practice relies on the use of less reliable pathogen indicators (coliform bacteria) than are proposed in the GO (*Salmonella*). Therefore, higher levels of pathogens may be applied to the land under the No-Project Alternative than under the proposed GO.

Animal manures may pose a threat to human health. Farm animals such as cattle, pigs, and chickens become infested and excrete a number of human pathogens in their feces. These include *Salmonella*, *Campylobacter*, *Yersinia*, *E. coli 0157:H7*, *Listeria* spp., and the protozoan parasite *Cryptosporidium.* Cattle manure is believed to be the major source of both water- and food-borne outbreaks of *E. coli* in the United States associated with lettuce and apples.

Although animals have not been known to be a source of human enteric viruses, recent studies shown that hepatitis E infects pigs and can be found in their feces. Two recent cases of hepatitis E in the United States are believed to have been associated with water- and food-borne outbreaks in the developing world (Meng et al. 1998).

## Land Use and Aesthetics

The No-Project Alternative would result in land use impacts similar to those of the proposed GO because setbacks for all types of sensitive receptors (e.g., recreational areas, educational areas) are not defined. Aesthetic impacts (e.g., reduction in visual quality) associated with biosolid haulers using roadways through residential and recreational areas would also be similar under this alternative. Therefore, land use and aesthetic impacts would be considered significant because additional setbacks and

defined truck access routes would not be required to help reduce visual and land use (e.g., traffic and noise) impacts on all types of sensitive receptors.

## Biological Resources

This alternative would result in similar impacts on biological resources because the preparation of a specific site assessment for special-status plant and wildlife species and/or biologically unique or sensitive natural communities is not a requirement under the No-Project Alternative for areas that have not been disturbed within the last year. Therefore, biological resource impacts would be considered potentially significant because the appropriate site assessment (e.g., for special-status species, sensitive natural communities) would not be required to help identify and compensate for any potential impacts on biological resources in the application area before they are affected by land application.

## Fish

Under this alternative, impacts on fisheries (e.g., acute toxicity) would be similar to those identified for the GO. Current practice provides for setbacks similar to those in the GO between land applications and water bodies with protected fish species. Because the land application of EQ biosolids is not regulated under current practice, there is some potential for adverse effects on fish where EQ material is applied or disposed of adjacent to streams.

## Traffic

Under the No-Project Alternative, the potential for traffic safety hazards resulting from the accidental spill of biosolids on local and regional roadways would be slightly greater than those identified for the proposed GO. The No-Project Alternative does not require implementation of a Spill Prevention Plan. However, it should be noted that several counties currently require that transporters implement various emergency procedures, including those associated with an accidental spill of biosolids.

## Air Quality

The No-Project Alternative would result in air quality impacts similar to those under the proposed GO because restrictions on the size and travel distance for specific biosolid application projects is not a requirement under either option. Air quality impacts could be significant because it is expected that application projects requiring more than 4,800 VMT

daily would generate daily transportation and application-related $NO_x$ emissions that would exceed significance thresholds for air districts where biosolids are applied in the greatest volumes.

In addition, current practice under the No-Project Alternative does not specifically restrict the movement of visible particulates from an application site. Therefore, it is possible that more nuisance particulates will escape land application sites under existing conditions than would occur under the proposed GO.

### Noise

As described above under "Land Use and Aesthetics", the No-Project Alternative would result in noise impacts similar to those of the proposed GO because defined truck access routes would not be required to help reduce transportation-related noise impacts on residential land uses. Consequently, noise impacts would be considered significant because there would be no control on the use of delivery routes adjacent to residential land uses. Also, setback requirements between land application operations and individual residences would be expected to be the same under both alternatives.

### Cultural Resources

This alternative would result in impacts on cultural resources similar to those of the proposed GO because cultural resource surveys would not be required for land applications in areas that had not been previously disturbed. Cultural resource impacts would be considered potentially significant because no cultural resource survey would be conducted to identify significant resources before ground disturbance begins.

## Modified GO Provisions and Specifications Alternative

As described above, this alternative addresses all the significant or potentially significant impacts resulting from implementation of the proposed GO and incorporates the mitigation measures identified in Table ES-1 as additional provisions or prohibitions..

### Soils, Hydrology, and Water Quality

The Modified GO Alternative includes measures that should improve groundwater and surface water protection compared with the level of protection provided by the proposed

GO. Although implementation of the proposed GO is not expected to result in significant water quality or hydrology effects, the GO modifications would include a data collection and evaluation step as part of the application process; this step would be designed to avoid application of biosolids in those unique settings where soil structure and chemistry could lead to leaching of nutrients or heavy metals into the groundwater. The additional data and evaluation would be especially valuable where biosolids land application was being planned over impaired or degraded groundwater basins. Professional help, as deemed necessary, would be required to estimate nitrogen application rates and appropriate irrigation management in areas where nitrate contamination of groundwater was judged to be a significant issue.

## Land Productivity

The Modified GO Alternative would result in fewer land productivity impacts than the proposed GO because the development and analysis of soils data would be required to avoid land application in those parts of California where existing soil conditions could contribute to declines in land productivity. Therefore, the ability of the land to support agricultural, horticultural, silvicultural, or land reclamation activities would be less likely to deteriorate over time because the implementation of these data collection and evaluation efforts would reduce the incidence of poor land management practices and minimize soil erosion. Additionally, under this alternative, biosolids application sites would be identified and monitored to address any potential public concerns regarding crop contamination.

## Public Health

~~Even though l~~Land application under the proposed GO ~~is not expected to~~would potentially result in a significant health ~~risks, application under t~~risk from human ingestion of pathogens on crops. The modified GO would reduce the risk ~~of public health impacts compared with the risk under the proposed GO because the application of biosolids would be better controlled in regions of California where soil conditions could allow leaching of nitrates and metals into the groundwater. Collection and evaluation of soils data would be required as a condition of applying for WDRs under the modified GO.~~ to a less than significant level by imposing grazing restrictions. These restrictions would avoid exposing the public to viable pathogens. Consequently, public health impacts would be considered less than significant.

## Land Use and Aesthetics

The Modified GO Alternative would result in fewer land use and aesthetic impacts than the proposed GO because the modified GO would include additional setbacks (up to 0.5

mile) for all sensitive land use areas and because the definition of an area having a "high potential for public exposure" would be expanded to include other sensitive land uses, such as hospitals and educational facilities. Consequently, land use and aesthetic impacts (i.e., disturbance through increased traffic and noise, odors, and visual impairment) would be considered less than significant because the setbacks would provide additional buffers to minimize these impacts.

## Biological Resources

This alternative would be expected to result in fewer impacts on biological resources compared with the proposed GO because the preparation of a specific site assessment for special-status plant and wildlife species and/or biologically unique or sensitive natural communities would be a requirement under the Modified GO for areas that have not been disturbed within the last year. Therefore, biological resource impacts would be considered less than significant because the appropriate site assessment would help to identify and compensate for any potential biological resources in the project area before they were adversely affected.

## Fish

Under this alternative, fisheries-related impacts would be less than those identified for the GO because additional setbacks would be required for land applications in the vicinity of internally drained water bodies with protected fish species.

## Traffic

This alternative would result in traffic impacts similar to those of the proposed GO. No significant effects would be expected.

## Air Quality

Under the proposed GO, the application of biosolids on sites that would require delivery truck traffic to exceed 4,800 vehicle miles per day would result in the generation of air emissions (e.g., combustion emissions, fugitive dust) that could exceed local air district thresholds for $NO_x$ and PM10. The Modified GO Alternative would result in fewer air quality impacts because it includes provisions that restrict the amount of vehicle traffic that can be generated by an individual project. This restriction would ultimately reduce

the potential for a specific project to exceed daily significance thresholds for emissions of $NO_x$, and PM10. Therefore, air quality impacts would be considered less than significant.

### Noise

The application of biosolids has the potential to result in transportation-related noise impacts on sensitive receptors located along delivery routes. This alternative would result in fewer transportation-related noise impacts than the proposed GO because the modified GO would restrict the use of delivery trucks near residential land uses to the extent possible. Consequently, noise impacts would be considered less than significant.

### Cultural Resources

This alternative would reduce the chance of damaging cultural resources because cultural resource surveys would be a prerequisite to applying biosolids in areas that had not previously been disturbed. Cultural resource impacts would be considered less than significant because the cultural resource investigation would help to identify any potential resources in the project area before they were adversely affected.

## Land Application Ban Alternative

As more fully described earlier, the land application of biosolids would not be facilitated by regulation under this alternative. Biosolids generators would be encouraged to pursue other management options such as use of landfills, incineration, and development of dedicated disposal sites.

### Soils, Hydrology, and Water Quality

Under the Land Application Ban Alternative, biosolids reuse would not have an effect on surface water or groundwater quality. Biosolids currently being applied to the land would eventually be diverted to disposal operations. Additional land application sites would not be developed. With these materials going to landfills, monofills, or incinerators, the potential for water quality effects would be reduced. Landfills and monofills are strictly regulated for contamination of surface water and groundwater. Most of these facilities have natural or manufactured liners that catch leachate, or they have extensive leachate collection systems that minimize percolation of contaminants to groundwater. Newly developed landfills or monofills would be expected to include state-of-the-art leachate control systems. Incinerators are enclosed facilities that do not generate a significant

liquid waste stream. It is assumed that incinerator ash would be disposed of in an appropriate landfill.

## Land Productivity

Under the Land Application Ban Alternative, adverse crop and soil productivity impacts associated with changes in soil nutrient levels and changes in heavy metal plant toxicity resulting from the application of biosolids would not occur. Additionally, public concerns over crop contamination from biosolids applications would not occur under this alternative. Other fertilization and soil amendment practices would continue to occur. These practices could include use of other organic fertilizers, such as manure. Use of chemical and manure-based fertilizers is not currently considered to have an effect on long-term land productivity. Studies are being undertaken, however, to determine the long-term effect of chemical fertilizer use on land productivity. Also, manure typically has a higher total dissolved solids content than biosolids, so changes in soil salinity could be more of an issue with manure use. Also, the loss of biosolids as a soil conditioner would have an adverse effect on land productivity in those situations in which there would be no option of using biosolids as an amendment on soils with low amounts of organic material.

## Public Health

If biosolids reuse is abandoned in favor of disposal alternatives in the future, there would be additional demand for landfill or monofill space, or perhaps for added incinerators. If new facilities are placed in rural settings, as is normal, potentially productive land could be eliminated by construction of facilities. These losses would be more long term than is likely at land application sites. This indirect effect of facilities siting efforts could be avoided if low-productivity lands were sought for new facilities.

Under this alternative, there would be no risk of human or animal disease from the land application of biosolids in agricultural, horticultural, silvicultural, or land reclamation settings. Land application would be discouraged and the pathogens and other contaminants in biosolids would not be placed in settings with a significant risk of public exposure. Most biosolids generated in the state would be transported to and disposed of in landfills, monofills, or incinerators. These types of facilities generally have stricter control on public access, so the potential for direct human contact would be substantially reduced.

One potential for an adverse effect under this alternative would be related to air emissions from biosolids incinerators. The increased incidence of biosolids incineration

would create increases in emission of particulates and other potential air contaminants, affecting residents in the vicinity of the incinerator (see "Air Quality" below). Emission control facilities on incinerators could be used to reduce the significance of this effect.

Agricultural sites currently using biosolids for soil conditioning and as a source of nutrients could, in the future, receive animal manures as an alternative. The public health implications of this change have not been investigated extensively, but the use of animal manures is not currently actively regulated. Some additional public health effects could result from this change in fertilizer source.

## Land Use and Aesthetics

The Land Application Ban Alternative would result in land use (e.g., traffic, noise) and aesthetic impacts (e.g., reduction in visual quality) similar to or greater than those of the proposed GO because of the need for increased Class II and Class III landfill space and more incinerators for biosolids disposal. This increased need for facilities has the potential to create greater land use and aesthetic impacts than the proposed GO because landfills and incinerators are much more visible elements of the landscape and have a much greater life expectancy than periodic land application.

## Biological Resources

This alternative would be expected to result in similar but much less extensive impacts on biological resources than the proposed GO because the potential need to expand existing landfill and incineration areas might also affect special-status plant or wildlife species or biologically unique or sensitive natural communities located within the expansion areas. These areas would be much smaller than land application sites in general, but may be similar in size to previously undisturbed areas that might be affected under the proposed GO. Biological resource impacts would be potentially significant under this alternative, and the appropriate site assessments (e.g., for special-status species, sensitive natural communities) would be required to help identify and compensate for any potential biological resources in the expansion areas before they are adversely affected.

## Fish

This alternative has the potential to result in fisheries impacts similar to those of the proposed GO because the potential need to expand existing landfill areas might also affect special-status fish species or biologically unique or sensitive natural communities located within the expansion areas. Fisheries impacts would be considered potentially significant under this alternative, and the appropriate site assessments (e.g., for special-

status species, sensitive natural communities) would be required to help identify and compensate for any potential fisheries resources in the expansion area before they are adversely affected.

## Traffic

Under the Land Application Ban Alternative, most biosolids would no longer be transported to agricultural, horticultural, silvicultural, or land reclamation areas as a source of nutrients and soil conditioning. Instead, this material would be transported to landfills, monofills, or incinerators for disposal. The truck traffic associated with moving this material to disposal sites rather than reuse sites may be greater or lesser than under the proposed GO, depending on the relative distances between these sites and the degree of dewatering that would take place before transport. However, with the effective ban on land application, those lands currently receiving biosolids would require other sources of nutrients and soil conditioners. Some level of truck traffic would be associated with supply of this replacement material. Consequently, it is likely that traffic related to switching from land application to disposal of biosolids would be greater than under the proposed GO. Also, a land application ban would not stop generators from using highways to transport biosolids out of the state.

## Air Quality

This alternative would result in greater air quality impacts than the proposed GO. With an effective ban on land application, incineration of biosolid materials would be expected to increase, resulting in $NO_x$ and PM10 emissions that could exceed local air district significance thresholds. Additionally, the incineration of biosolid materials may result in the release of minimal amounts of hazardous materials emissions, which may create a public health hazard. The transportation of fertilizers to existing agricultural operations and the delivery of biosolids materials to landfill areas would also result in elevated levels of transportation-related $NO_x$ and PM10 emissions. Consequently, because of the increase in both incineration and transportation-related emissions and the potential to exceed local air district significance thresholds under the Land Application Ban Alternative, air quality impacts are expected to be greater under this alternative. Also, a land application ban would not stop generators from using highways to transport biosolids out of the state.

## Noise

As described above in the traffic analysis, agricultural operations would continue to receive a source of nutrients and soil conditioning, resulting in a similar number of truck trips and resultant noise impacts. Additionally, under this alternative a number of truck trips associated with the transport of biosolids materials to out-of-state landfills and incineration sites would be generated, resulting in additional transportation-related noise impacts on sensitive receptors located along landfill access routes. Consequently, because of the increased noise levels caused by the additional number of trucks generated by the Land Application Ban Alternative, noise impacts are expected to be greater than for the proposed GO.

### Cultural Resources

This alternative could result in cultural resource impacts similar to those described for the proposed GO. Previously undisturbed land could be used for construction of additional landfill, monofill, or incineration facilities as biosolids are diverted from land application. The size of lands needed for new facilities would be smaller than the total acreage used for land application, but the size may be similar to the amount of undisturbed land that would be used under the proposed GO. Significant cultural resource impacts could occur as new disposal facilities are constructed, making it necessary to conduct appropriate site surveys to avoid or develop compensation for cultural resources lost or damaged in the process.

## Class A Only Alternative

The Class A Only Alternative is compared to the proposed GO, before mitigation. Because it incorporates a number of mitigating features, this alternative would result in less severe impacts than the proposed GO in several areas. This alternative would result in more severe impacts than the proposed GO in the areas of traffic, air quality, and energy consumption.

Increased energy consumption when compared to the proposed GO is related to two factors: increased energy needs of Class A biosolid treatment, and increased fuel needs related to longer truck trips. The technology for treating biosolids to Class A standard generally requires a substantially greater energy input (for heating, turning, aeration/air transfer, etc.) than is necessary to reach Class B standards. As discussed below under traffic, the Class A Only Alternative would result in longer truck trips because Class B land application sites would be available only in other states.

### Soils, Hydrology, and Water Quality

Class A biosolids are similar in composition to Class B biosolids; differing primarily in the absence of pathogens. Therefore, the Class A Only Alternative would result in similar impacts to soils as the proposed GO. With regard to hydrology and water quality, Class A biosolids contain nutrients, trace elements, and synthetic organic compounds which could affect surface and groundwater quality. However, the application of Class A biosolids would be subject to regulation to ensure that they are not applied in such a way that would exceed specified requirements. The impacts would be no greater than those identified for the proposed GO.

## Land Productivity

The Class A Only Alternative would result in impacts similar to the proposed GO.

## Public Health

The Class A Only Alternative would have a less than significant impact in all areas under public health. Limiting land application to Class A biosolids only could avoid impacts related to public exposure to pathogens that would result if public access regulations for Class B biosolids were not followed. Overall, this impact of this alternative would be less severe than the proposed GO.

## Land Use and Aesthetics

The Class A Only Alternative would not have any impacts that are more severe than the proposed GO in this area. Further, with the mitigating features made a part of the Class A Only Alternative, it would have a less-than-significant impact on visual quality. Overall, the impact of this alternative would be less severe than the proposed GO.

## Biological Resources

The Class A Only Alternative would incorporate mitigating features that would result in a less than significant impact on biological resources. As a result, the impact of this alternative would be less severe than the proposed GO.

## Fish

The Class A Only Alternative would incorporate mitigating features that would result in a less than significant impact on fish. As a result, the impact of this alternative would be less severe than the proposed GO.

## Traffic

The additional cost of Class A treatment, in comparison to Class B treatment, could lead to an increase in the amount of Class B biosolids being trucked out-of-state for beneficial use. This is already occurring as a result of local restrictions on the use of Class B biosolids now being imposed in Kern and Kings Counties. The amount of biosolids being transported out of state by truck is increasing. The Arizona Department of Environmental Quality estimates that in the year 2001 approximately 1,014 dry tons of biosolids were transported from California producers (primarily from Southern California) to sites in Arizona. In 2002, approximately 59,906 dry tons were brought in from California. Of this, approximately 34,917 dry tons were applied to land, 8,649 dry tons were composted, and 16,340 tons were disposed of in landfills. The Department's biosolids coordinator expects that, when compiled, the 2003 tonnage will be greater still. (Reed pers. comm.) A non-published CASA survey estimates that over 105,000 dry tons of biosolids produced by Southern California sanitation agencies were transported to and managed in Arizona and Nevada in 2003. In some cases, over 1/3 of the particular agency's 2003 output was transported out of state. (Hudnall pers. comm.)

To relate the dry volume being transported to the number of truck trips, a truck will haul approximately 24 tons of biosolids per trip, on average. (Gillette pers. comm.) Although the actual number of truck trips is unknown, a reasonable estimate is 4,375 one-way trips (i.e., 8,750 trips in both directions) to Arizona and Nevada receiving sites per year. These trips would be distributed among the Southern California biosolids producers and have a variety of origin and end places.

While the number of out-of-state truck trips is increasing, so is the length of trip. As an example of the distance that biosolids are being transported, one Southern California biosolids producer is currently hauling Class B biosolids from 290 to 370 miles one-way to land application sites in Arizona and Nevada. In contrast, when agricultural sites were available in Kern and Kings Counties, the one-way trip was approximately 200 miles or less (Baroldi 2003).

This outcome would be expected when the cost of Class A treatment exceeds the cost of Class B treatment plus the cost of transport out of California. Assuming generally that the Class A Only Alternative would result in a reduction of the volume of biosolids being applied in California, then this alternative would have a less severe impact on local traffic

in California than would the proposed GO. With the loss of biosolids as a soil amendment, those lands currently receiving Class B biosolids would require other sources of nutrients and soil conditioners. Some level of traffic would be associated with supplying this replacement material, but it would likely be less than that associated with biosolids application, particularly if chemical fertilizers are used. At the same time, long-distance traffic would increase on major highways to Nevada and Arizona.

If the application of Class B biosolids is essentially prohibited in California, sanitation agencies can be expected to continue to increase the dry tonnage of biosolids that are being transported out-of-state. Although the impact cannot be quantified by number of trips per east-west highway because the origins and ends of the trips are various, overall the substantially longer truck hauls from producer to application site and the increasing number of these truck trips can reasonably be assumed to result in a more severe impact than under the proposed GO. However, the impact would still be less than significant.

## Air Quality

The additional cost of Class A treatment, in comparison to Class B treatment, may lead to an increase in the amount of Class B biosolids being trucked out-of-state for beneficial use. Overall, additional truck traffic on southern routes to Nevada and Arizona would incrementally increase air emissions. The Class A Only Alternative would have a more severe impact than the proposed GO. Overall, the impact would be less than significant with the mitigating features incorporated into this alternative.

## Noise

Primary noise impacts would arise from transportation. The Class A Only Alternative would incorporate mitigating features that would result in a less than significant noise impact on sensitive receptors. As a result, the impact of this alternative would be less severe than the proposed GO.

## Cultural Resources

The Class A Only Alternative would incorporate mitigating features that would result in a less than significant impact on cultural resources. As a result, the impact of this alternative would be less severe than the proposed GO.

## Cumulative Impacts

The Class A Only Alternative would result in greater contributions than the proposed GO to cumulative effects on traffic, air quality, and energy consumption. Increased truck traffic on major roads between southern California and land application sites in Nevada and Arizona will make a cumulatively considerable contribution to traffic impacts. This alternative would make a cumulatively considerable contribution to air quality impacts (ozone precursors and particulate matter) related to truck emissions in the South Coast and Mojave air basins. This alternative would also contribute to energy consumption as a result of the more energy-intensive technology necessary to treat biosolids to Class A standard, in comparison to the energy level necessary for Class B treatment.

## Food Crop Limitation Alternative

The Food Crop Limitation Alternative differs substantially from the proposed GO. The proposed GO would, consistent with EPA Part 503 regulations, allow the application of Class A and Exceptional Quality biosolids to food crops without limitation. The proposed GO also allows the application of Class B biosolids subject to certain limitations. In contrast, the Food Crop Limitation Alternative would either (a) ban biosolids from any land that is to produce food crops or (b) prohibit the use of any biosolids on food crops for the 38 months prior to harvest.

The Food Crop Limitation Alternative differs from the Land Application Ban Alternative in that the latter would not allow the application of any biosolids. The Food Crop Limitation Alternative would either ban biosolids from lands producing food crops or allow application to lands producing food crops 38 months prior to harvest.

In the following discussions, the Food Crop Limitation Alternative is compared to the proposed GO, before mitigation. Because it incorporates a number of mitigating features, the Food Crop Limitation Alternative would result in less severe impacts than the proposed GO in several areas. This alternative would result in more severe impacts than the proposed GO in the areas of traffic and air quality.

### Soils, Hydrology, and Water Quality

The Food Crop Limitation Alternative would allow the application of the same types of biosolids that may be applied under the proposed GO, but over a more limited area. The impact of the alternative would be less than significant. Overall, this alternative would have a less severe impact than the proposed GO.

## Land Productivity

Under the Food Crop Limitation Alternative, the application of biosolids to food crops would be significantly reduced. Under either of the sub-alternatives, once biosolids are applied, the use of that land for food crops will be severely restricted. Assuming that most farmers would not choose to switch exclusively to non-food crops in order to continue to apply biosolids, this alternative would result in a de facto ban on the use of biosolids on food crops. As a result, more chemical and manure-based fertilizers would be used.

When biosolid application is ceased, food crops (particularly those on marginal lands) would no longer benefit from the improved nitrogen levels and water retention capacity that can result from application. To compensate, use of chemical and manure-based fertilizers will increase.

This alternative would apply stricter reporting requirements to WDR applicants than the proposed GO. In addition, the Food Crop Limitation Alternative would result in a less than significant impact relative to public concerns about crop contamination since it would limit the future use of land to which biosolids had been applied. Overall, the impact of this alternative would be less severe than the proposed GO.

## Public Health

Although there is no evidence that the application of Class A, Class B (with restrictions), or Exceptional Quality biosolids results in creation of a public health risk, the Food Crop Limitation Alternative would have even stronger assurances against the possible transfer of pathogens and other substances to food crops than would the proposed GO. Limiting land application to non-food crops would reduce impacts related to public exposure to pathogens. In addition, this alternative would apply stricter public health related requirements than the proposed GO. Overall, the impact of this alternative would be less severe than the proposed GO.

## Land Use and Aesthetics

The Food Crop Limitation Alternative would result in a reduction in the amount of land to which biosolids would be applied. As a result, the impacts identified under the proposed GO would be less severe under this alternative. The Food Crop Limitation Alternative would not have any impacts that are more severe than the proposed GO in this area. Further, with the mitigating features made a part of the Food Crop Limitation Alternative,

it would have a less-than-significant impact on visual quality. Overall, the impact of this alternative would be less severe than the proposed GO.

## Biological Resources

The Food Crop Limitation Alternative would result in a reduction in the amount of land to which biosolids would be applied. In addition, it would incorporate mitigating features that would result in a less than significant impact on biological resources. As a result, the impacts identified under the proposed GO would be less severe under this alternative.

## Fish

The Food Crop Limitation Alternative would probably result in a reduction in the amount of land to which biosolids would be applied. In addition, it would incorporate mitigating features that would reduce any impacts on fish to a less than significant level. As a result, the impacts identified under the proposed GO would be less severe under this alternative.

## Traffic

Under the Food Crop Limitation Alternative, a portion of the biosolids being applied to land would no longer be transported to agricultural areas in California to be used as a source of nutrients and soil conditioning. Instead, this material would be transported to landfills, incinerators, or lands outside of California for disposal and beneficial use. As discussed in the traffic impact section under the Class A Only Alternative, the truck traffic associated with transporting a larger proportion of the biosolids to out-of-state sites would be greater than under the proposed GO. However, with the loss of biosolids as a soil amendment, those food crops currently receiving biosolids would require chemical or manure-based sources of nutrients and soil conditioners. Some level of traffic would be associated with supplying this replacement material, but it would likely be less than that associated with biosolids application, particularly if chemical fertilizers are used. At the same time, long-range truck traffic would be expected to increase to carry biosolids to out-of-state beneficial use sites. Consequently, it is likely that the traffic associated with both biosolids beneficial use and disposal and delivery of chemical/manure-based soil amendments would be greater than under the proposed GO. In addition, the substantially longer truck hauls from producer to application site would result in a more severe impact than under the proposed GO. However, the impact would still be less than significant.

## Air Quality

As discussed above, the level of traffic associated with the Food Crop Limitation Alternative would be expected to be greater than the proposed GO. To some extent, this alternative may lead to increases in incineration of biosolids if the cost is competitive with the cost of transport of biosolids to out of state beneficial use areas. Increased truck traffic through the South Coast and Mojave air basins would result in increased emissions. The Food Crop Limitation Alternative would have a more severe impact than the proposed GO. However, overall, the impact would be less than significant.

## Noise

Primary noise impacts would arise from transportation. The Food Crop Limitation Alternative would incorporate mitigating features that would result in a less than significant noise impact on sensitive receptors. As a result, the impact of this alternative would be less severe than the proposed GO.

## Cultural Resources

The Food Crop Limitation Alternative would incorporate mitigating features that would result in a less than significant impact on cultural resources. As a result, the impact of this alternative would be less severe than the proposed GO.

## Cumulative Impacts

Food Crop Limitation Alternative would result in greater contributions than the proposed GO to cumulative effects on traffic, air quality, and energy consumption. Increased truck traffic on major roads between southern California and land application sites in Nevada and Arizona would make a cumulatively considerable contribution to traffic impacts. In addition, this alternative would make a cumulatively considerable contribution to quality impacts (ozone precursors and particulate matter) related to truck emissions in the South Coast and Mojave air basins. The increased distances over which biosolids would be transported, compared to current practice, would increase the amount of fuel consumed by transport trucks.

# Chapter 15. Mitigation Monitoring Program

# Chapter 15. Mitigation Monitoring Program

Mitigation measures are a wide range of conditions and controls placed on a project to reduce its impacts on the environment. CEQA requires the use of mitigation measures to reduce the magnitude of impacts.

When an agency approves a project and adopts mitigation measures for potentially significant impacts disclosed by an EIR, the project proponent is required by California state law (Pub. Res. Code Section 21081.6) to establish a monitoring and reporting program to ensure that the mitigation measures are implemented. This Mitigation Monitoring Program will be considered for adoption by the SWRCB at the time the EIR is adopted.

The Mitigation Monitoring Program identifies mitigation measures reduce impacts to a less-than-significant level for the proposed project. For each mitigation measure, Table 15-1 identifies the monitoring and enforcement action, timing for implementing the measure, the entity responsible for implementing the measure, and the entity responsible for monitoring and enforcing implementation.

# Table 15-1.
# Mitigation Monitoring Program

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| | **Land Productivity** | | | |
| **4-1: Provide Soil- and Site-Screening Information with the Pre-Application Report.** The GO Pre-Application Report should be revised to require that WDR applicants provide sufficient soil and site information such that RWQCB staff can determine whether soils would be degraded and/or land productivity would be reduced as a result of biosolids application. In particular, providing the information is intended to ensure that 1) essential soil nutrients other than nitrogen are applied so that significant nutrient imbalances do not occur, 2) metals-related phytotoxicity does not occur, 3) metal- related forage toxicity or mineral deficiencies and other trace metals related problems do not occur on hay lands and pasture lands, 4) increases in salinity do not occur to the point that the yields of the crop(s) typically grown at the site is appreciably reduced, and 5) appreciable accelerated soil erosion does not occur. | The GO will be revised to include the development and use of a screening tool to identify sites where management of soil fertility, heavy metals, phytotoxicity and nutrient and heavy metals bioavilability and mobility may become a problem if biosolids are applied | Before adoption of GO | SWRCB | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| **4-1. Continued** | | | | |
| The Pre-Application Report already requires sufficient information with which effects of potential nutrient imbalances, metals phytotoxicity, and excessive salinity can be analyzed. This information should be used by certified soil scientist, civil engineer, agricultural engineer or a certified agronomist to evaluate the above potential effects on land productivity. The soil scientist, civil engineer, agricultural engineer and/or agronomist should make recommendations in a letter report to accompany the Pre-Application report regarding the proper rate of biosolids applications, any soil management (e.g., supplemental fertilizers and pH adjustment), appropriate crop, and grazing practice recommendations, considering the nature of the application site soils and biosolids characterization data, and the need to preserve short-term and long-term land productivity. GO Pre-Application Report also should be amended to include the erosion hazard (derived from USDA soil survey reports[1]) | | | | |

[1] Where a soils survey report is not available for a proposed application site, the applicant should have a qualified soil scientist determine the erosion hazard (using NRCS guidelines), unless the slope of the site is 3% or less. Sites with slopes of 3% or less will be considered to have a slight erosion hazard.

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| **4-1. Continued** | | | | |
| of the proposed application site. As is currently done for the recognition of potential hydric (wetland) soils under Section 404 of the Clean Water Act, the soil screening tool could be developed based on existing U.S. Natural Resources Conservation Service (NRCS) soil survey information and a list of possible problem soil-series types. Alternatively, the screening criteria could be based on Soil Taxonomy, using, for example, the taxonomic Great Group and family-differentiating criteria such as particle size, reaction class, and mineralogy classes (e.g., Psamments or Aquents). | | | | |
| Additionally, the Limitation to Land Application table hereafter should be added to the GO Pre-Application Report. Applicants or qualified soil scientists or agronomists should use the table to further determine whether soils could be degraded or land productivity reduced. | | | | |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|

**4-1. Continued**

**Limitations to Land Application**

| Parameter | Slight | Moderate | Severe |
|---|---|---|---|
| Cation exchange capacity[a] (average milliequivalents per 100 g, 0-20 inches depth | >15 | 10-15 | <10 |
| pH[b] (average 0-20 inches depth) | >6.5 | 5.0 to 6.5 | <5.0 |
| Erosion hazard rating[c] | None to slight | Moderate | High to severe |

[a] Cation exchange capacity limits based on professional judgment.
[b] pH limits based on U.S. Department of Agriculture (1993).
[c] Erosion hazard limits based on professional judgment.

Samplings of biosolids and soils should follow EPA/DHS procedures and protocols specified in the National Sewage Sludge Survey (U.S. EPA 1988).

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| **4-1. Continued** | | | | |
| Provided that the applicant, a soil scientist, civil engineer, agricultural engineer or agronomist has provided written confirmation to the RWQCB that soils would not be degraded and/or land productivity would not be reduced as a result of nutrient imbalances, metals-related phytotoxicity, or adverse salinity effects, biosolids may be applied on any site with a “slight” limitation as defined in the table. At sites with a “moderate” limitation, biosolids may be applied only where the crop is not known to be particularly sensitive to metals and nutrient imbalances or is not known to be bioaccumulative of heavy metals. Sites with a “severe” limitation are excluded from eligibility under the GO and a site-specific waste discharge investigation and planning study should be conducted by a qualified soil scientist or agronomist to provide, in writing to the RWQCB, written confirmation that biosolids application would not cause soil degradation and would not reduce crop yield. | | | | |
| The GO and the Pre-Application Report also should be amended to specify an absolute upper slope limit of 20% at sites in which the biosolids would not be immediately covered by sod or a sufficient mulch cover to control erosion. | | | | |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| **4-2: Extend Grazing Restriction Period to Allow for SOC Biodegradation.** For grazing sites where biosolids applications are proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after land application. The GO should also be revised to require that grazing of animals be deferred for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum biodegradation of SOCs and pathogens before grazing animals are exposed to the soil. Refer also to Mitigation Measure 4-1, which requires comprehensive testing and analysis of soils and biosolids by qualified professionals. | The GO will be revised to extend the grazing restriction period to allow for SOC biodegradation. | Before adoption of GO | SWRCB | RWQCB |
| **4-3: Track and Identify Biosolids Application Sites.** A program to identify and track applications of biosolids on agricultural lands should be established to mitigate the potential perception by produce buyers and consumers that crops have been contaminated or damaged by biosolids applications. The program should allow for public access to information.. The program should also identify previous biosolids incorporation sites and add them to the tracking system. | A program to track and identify biosolids application sites will be established | Following adoption of GO | SWRCB | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| | **Public Health** | | | |
| **5-1: Review Manual of Good Practices.** Although no significant public health risk is expected from direct human contact with biosolids, it is recommended that all individuals or agencies receiving land application permits under the GO review a manual of good practices that addresses measures to protect human health. The California Water Environment Association Manual of Good Practice—Agricultural Land Application of Biosolids is an example of such a manual (California Water Environment Association 1998). | Manual of Good Practices will be reviewed | Before land application | Discharger | SWRCB |
| **5-2: Extend Grazing Restriction Period to Allow for Pathogen Reduction.** For grazing sites where application of biosolids is proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after application. The GO should also require that grazing of animals be deferred for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum degradation of pathogens (and SOCs) before grazing animals are exposed to the soil. See also Mitigation Measure 4-2. | The GO should be revised to state that the grazing of animals be deferred for at least 90 days following application and include grazing restrictions based on daily temperatures | Before adoption of the GO | SWRCB | RWQCB |
| **5-3: Implement Good Management Practices.** As part of good management practices, it is recommended that workers who are loading or working near sites where Class B biosolids are mixed or loaded or are applied by surface spreading wear respirators or masks to protect against inhalation of aerosols or fine particles derived from the biosolids being handled. | It is recommended that workers who are loading or are working near Class B biosolids wear masks or respirators | During land application operations | Applier | Applier |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| | **Land Use and Aesthetics** | | | |
| **5-4: POTW Operators Maintain Awareness of Potential Radioactive Materials in the Wastestream.** As part of its GO, the SWQCB shall require the operators of POTW that produce biosolids that are to be applied to land to follow the recommendations contained in the ISCORS Assessment of Radioactivity in Sewage Sludge: Recommendations on Management of Radioactive Materials in Sewage Sludge and Ash at Publicly Owned Treatment Works for screening, identification, and consultation. | The GO will be modified to require operators to follow ISCORS recommendations | Before adoption of GO | SWRCB | SWRCB |
| **6-1: Require injection of biosolids in areas defined as having a high potential for public exposure for Class B biosolids**. The GO will be modified to state that no application of Class B biosolids shall be permitted within an area defined in the GO as having a high potential for public exposure unless the biosolids are injected into the soil. | Class B biosolids will be injected at the application site if they are applied in areas defined as having a high potential for public exposure | During land application | Discharger | RWQCB |
| **6-2: Require the Maintenance of Biosolids Transport Trucks after Biosolids Are Loaded in the Trucks.** The GO will be modified to stipulate that dischargers ensure that any biosolids adhering to the outside of biosolids transport trucks and tires be removed before trucks leave the dischargers' sites. Implementation of this mitigation measure will prevent biosolids from being spilled in roadways. | The GO will be modified to require the maintenance of biosolids transport trucks | Before adoption of GO | SWRCB | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| | **Biological Resources** | | | |
| **7-1: Conduct a Site Assessment on Natural Terrestrial Habitat and Fallow Lands for Special-Status Plant and Wildlife Species.** The NOI should be modified to include a section for the applicant to indicate whether the site where biosolids would be applied has been fallow for more than 1 year. RWQCB staff will evaluate each project to determine if the biosolids would be applied to natural terrestrial habitats or any lands that have been fallow for more than 1 year and that have not been continually disked. If RWQCB staff determines that natural terrestrial habitats or lands that have been fallow for more than 1 year are present on the project site, a site assessment must be conducted to determine whether there is potential for special-status species to occur and whether or not they could be affected by the application of biosolids; this report must be forwarded to the appropriate regional office of the DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy. If there are no special-status species present, RWQCB may continue with the project evaluation. If special-status species could be affected, the project would not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on special-status species, obtains the appropriate permits, and agrees to implement the mitigation. | The GO will be modified to include biological information in the NOI and site assessments will be conducted on natural terrestrial habitat and follow lands for special-status plant and wildlife species | Before issuance of Notice of Applicability | SWRCB<br>Discharger | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| **7-2: Conduct a Site Assessment on Natural Terrestrial Habitats for Biologically Unique or Sensitive Natural Communities.** The NOI should be modified to include a section for the applicant to indicate whether the site where biosolids will be applied is an existing agricultural operation or whether it could contain biologically unique or sensitive natural communities. RWQCB staff will evaluate each project to determine whether the biosolids would be applied to natural terrestrial habitats. If RWQCB staff determines that natural terrestrial habitats are present on the project site, a site assessment must be conducted to determine whether biologically unique or sensitive natural communities occur and whether they could be disturbed by the application of biosolids; this report must be forwarded to the appropriate regional office of the DFG and the Endangered Species Unit of the USFWS in Sacramento for review and approval of the mitigation strategy. If there are no biologically unique or sensitive natural communities present, RWQCB may continue with the project evaluation. If biologically unique or sensitive natural communities are present and more than 10% or 10 acres would be disturbed, whichever is less, the project would not be authorized under the GO unless the applicant submits a plan to mitigate for any significant impacts on biologically unique or sensitive natural communities and agrees to implement the mitigation. | The GO will be modified to include biological information on the NOI and a site assessment on natural terrestrial habitats for biologically unique or sensitive natural communities will be conducted | Before issuance of Notice of Applicability | SWRCB<br>Discharger | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| | **Fish** | | | |
| **8-1: Increase Setback from Enclosed Water Bodies If Pupfish Are Present.** Proposed land applications in the habitat range of the pupfish should be reviewed for their proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet should be required. There are several species of pupfish in southern California. Their current occupied habitat is confined to several small springs, Salt Creek and the Amargosa River in southern Inyo and northern San Bernardino counties in the vicinity of Death Valley National Monument, and San Felipe Creek and the Salton Sea in Imperial County. Exact locations of habitat can be found in Moyle et al. 1989. | NOI will be reviewed to determine if proposed land applications are within the habitat range of the pupfish. If pupfish are present, 500-foot setbacks from water bodies will be established | Before issuance of Notice of Applicability and during land application | RWQCB | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| | **Noise** | | | |
| **11-1: Avoid the Use of Haul Routes near Residential Land Uses.** The project applicant and or transporter will avoid the use of haul routes near residential land uses to the extent possible. If the use of haul routes near residential land uses cannot be avoided, the project applicant and or transporter will limit project-related truck traffic to daylight hours. | Haul routes near residential land uses will be avoided to the extent possible | During biosolids transport | Discharger | RWQCB |
| | **Cultural Resources** | | | |
| **12-1: Conduct a Cultural Resources Investigation.** A cultural resources investigation should be conducted before disturbance is permitted on land that has not been disturbed previously. The cultural resources investigation should include a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. This records search should include, at a minimum, contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination can be made regarding whether previously identified cultural resources would be affected by the proposed project and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey may need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If the impact is unavoidable, mitigation should be determined on a case-by-case basis. | A cultural resources investigation will be conducted on undisturbed lands | Before issuance of Notice of Applicability | Discharger | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| **12-2: Comply with State Laws regarding Disposition of Native American Burials, If Such Remains Are Found.** If human remains of Native American origin are discovered during project activities, it is necessary to comply with state laws relating to the disposition of Native American burials, which are under the jurisdiction of the Native American Heritage Commission (Pub. Res. Code Section 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains will stop until:<br>g the county coroner has been informed of the discovery and has determined that no investigation of the cause of death is required; and<br>g if the remains are of Native American origin,<br>– the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work, for means of treating or disposing of the human remains and any associated grave goods with appropriate dignity, as provided in Public Resources Code Section 5097.98, or<br>– the Native American Heritage Commission is unable to identify a descendant or the descendant failed to make a recommendation within 24 hours after being notified by the commission. | State laws regarding disposition of Native American burials will be complied with | During land application | Discharger | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| **12-2. Continued** | | | | |
| According to the California Health and Safety Code, six or more human burials at one location constitute a cemetery (Section 8100) and disturbance of Native American cemeteries is a felony (Section 7052). Section 7050.5 requires that construction or excavation be stopped in the vicinity of discovered human remains until the coroner can determine whether the remains are those of a Native American. If the remains are determined to be Native American, the coroner must contact the California Native American Heritage Commission. | | | | |
| **Cumulative Impacts** | | | | |
| **13-1: Minimize Contribution to Groundwater Nitrate Contamination from Land Application of Biosolids Conducted under the GO.** As a condition for the review of each individual NOI submitted for a proposed biosolids application project under the GO, the RWQCB engineer responsible for issuing the NOA would:<br>g evaluate whether the proposed discharge would occur within an area designated as having existing nitrate contamination problems and<br>g evaluate whether the proposed discharge would pose an imminent threat of contributing to or causing exceedances of water quality standards for nitrate. | RWQCB to review application and discharger to modify discharge activities or provide additional information on potential violation of water quality standards | Before issuance of NOA | RWQCB<br>Discharger | RWQCB |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| **13-1. Continued** | | | | |
| If the responsible engineer finds that either condition exists, the RWQCB would minimize the potential water quality impacts of the project by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the proposed discharge would not cause or contribute to violations of water quality standards. Verification that the proposed project would not cause or contribute to water quality degradation would require that sufficient information be submitted by a qualified civil engineer, agricultural engineer, or other professional hydrogeologist or water quality specialist such that the RWQCB engineer could make a finding that the proposed discharge would be in compliance with provisions of the GO. If the RWQCB finds that modifications to the proposed discharge are necessary for compliance with provisions of the GO, such modifications would consider, but would not be limited to, the following: | | | | |
| **g** requirements for the discharger to use the services of a certified agronomist, crop advisor, or agricultural engineer to develop additional management practices related to: 1) determining the agronomic rate for biosolids application projects that includes all sources of nitrogen applied to the application site; 2) developing overall farm water, cropping, and fertility management practices; and 3) evaluating the potential for nitrate leaching or impairment of offsite groundwater use; | | | | |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
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| **13-1. Continued** | | | | |
| **g** requirements of the discharger to provide additional groundwater monitoring in areas where groundwater is found at depths greater than 25 feet or there exist other identified local hydrogeologic conditions that could make the groundwater susceptible to contamination; | | | | |
| **g** requirements of the discharger to identify whether the proposed biosolids application site is within an area where Drinking Water Source Water Assessment and Protection (DWSWAP) Program setback requirements are implemented for municipal and domestic wells; and | | | | |
| **g** requirements of the discharger to consider the unique local site and hydrogeologic conditions in the design of the project and/or other groundwater quality management or regulatory programs that are currently active in the area. | | | | |

| Mitigation Measures | Monitoring and Enforcement Action | Timing of Action | Implementation | Monitoring and Enforcement Responsibility |
|---|---|---|---|---|
| **13-2: Reduce Sources of Nitrate Contamination.** The SWRCB would continue to identify causes of cumulative nitrate loading in nitrate sensitive groundwater areas and develop an effective strategy for reducing those sources. An effective strategy may include, but would not be limited to, the following:<br><br>g Each RWQCB should implement existing groundwater pollution protection permit programs and policies to prevent or reduce nitrate contamination of groundwater. Such a program may include evaluating increased enforcement procedure, or modifying the permitting programs for other agricultural activities (e.g., confined animal feeding operations, dairies, poultry farms), industrial and municipal NPDES-permitted discharges of wastes and reclaimed water to land, and NPDES storm water management regulations.<br><br>g Other local, state, and federal permitting authorities should evaluate, integrate, increase enforcement of, or modify their existing policies and procedures to reduce the cumulative contribution of nitrates to groundwater. Examples of other regulatory programs that should be evaluated and considered in areas that would have biosolids application include groundwater management programs, residential onsite septic tank system approval, municipal landfill management plans, agricultural cooperative extension programs, and forestry management programs. | Sources of nitrate contamination will be controlled | Ongoing | RWQCB | SWRCB |

# Chapter 16. Citations

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Director, Centers for Disease Control and Prevention. Washington, D.C. December 23, 2003

# Chapter 17. Report Preparation

# Chapter 17. Report Preparation

This draft EIR has been prepared by Jones & Stokes Associates and its subconsultants in association with the California State Water Resources Control Board. Additionally, Benton Price (The Merriwood Corporation) and Dr. Charles Gerba (University of Arizona) provided consultation or peer review during the preparation of this draft EIR. The following organizations, firms, and individuals who contributed to this report are listed below.

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# Appendix A. Draft Text of the General Order

**STATE WATER RESOURCES CONTROL BOARD**
**WATER QUALITY ORDER NO. 2000-___-DWQ**

**GENERAL WASTE DISCHARGE REQUIREMENTS FOR THE DISCHARGE OF BIOSOLIDS TO LAND FOR USE AS A SOIL AMENDMENT IN AGRICULTURAL, SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES (GENERAL ORDER)**

The State Water Resources Control Board (hereinafter referred to as the SWRCB) finds that:

1. Applications for the use of treated municipal sewage sludge meeting the requirements specified in Part 503 in Title 40 of the Code of Federal Regulations (CFR) (hereinafter referred to as biosolids) as a soil amendment have been received and waste discharge requirements (WDRs) have been issued by several of the nine Regional Water Quality Control Boards (RWQCBs). Section 13274 of the California Water Code (CWC) requires the SWRCB or RWQCBs to prescribe General WDRs for the discharge of biosolids used as a soil amendment. This General Order is intended to satisfy the requirements of CWC section 13274 and is intended for discharges of biosolids for use as a soil amendment. This General Order assists in streamlining the regulatory process for such discharges but may not be appropriate for all sites using biosolids due to particular site-specific conditions or locations. Such sites are not precluded from being issued individual WDRs. For the purposes of this General Order, biosolids do not include septage. Biosolids material applicable for coverage under this General Order is as described below:

   a. All Class A biosolids not meeting the requirements contained in Table 3 of 40 CFR Part 503.13 and Class B biosolids that are land applied for agricultural, silvicultural, horticultural, and land reclamation activities;

   b. All Exceptional Quality (EQ) biosolids-derived mixtures consisting of more than or equal to 50 percent biosolids (dry weight) applied at more than 10 dry-tons per acre per year for use as a soil amendment to continuous fields/plots greater than 20 acres for agricultural, silvicultural, horticultural, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company, or partnership;

   c. All EQ biosolids-derived mixtures consisting of 50 percent biosolids or less (dry weight) applied at more than 20 dry-tons per acre per year for use as a soil amendment to continuous fields/plots greater than 20 acres for agricultural, silvicultural, horticultural, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company, or partnership.

2. EQ biosolids may not necessitate regulation in the future. However, it is believed that large scale uses currently require oversight regardless of the actual threat to water quality while done at agronomic rates and using best management practices. Accordingly, this General Order can be applied to such sites to ensure that biosolids are being properly used and are not used in an activity of unregulated dumping. This regulatory tool may be used to regulate material that is land applied at a high loading rate in order to discourage poor biosolids management and to reduce risk to the public and the environment.

3. Within this General Order, the following terms are described as follows:

   a. Agriculture: The practice, science, or art of using the soil for the production of crops and/or raising livestock for human use.

   b. Agricultural Mineral: Any material containing nitrogen, available phosphoric acid, or soluble potash, singly or in combination, in amounts less than 5 percent or any substance containing essential secondary nutrients or micronutrients that is distributed for use in agriculture, silviculture, horticulture, and land reclamation activities for the purpose of promoting plant growth.

   c. Agronomic Rate: The nitrogen requirements of a plant needed for optimal growth and production, as cited in professional publications for California by the County Agricultural Commissioner or recommended by a Certified Agronomist or Certified Soil Scientist.

   d. Applier: Person, group of persons, or company that applies biosolids for use as a soil amendment.

   e. Arid: Arid lands are those areas where the longterm annual average rainfall is below 250 millimeters (less than 10 inches).

   f. Biosolids: Sewage sludge that has been treated and tested and shown to be capable of being beneficially and legally used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under 40 CFR Part 503.

   g. Buffer Zones: An area of land that provides a separation distance between the land application site and an area of concern.

   h. Class A Biosolids: Biosolids meeting the vector attraction, and meeting pollution concentration limits specified in 40 CFR Part 503 and pathogen reduction standards specified in 40 CFR Part 503.32(a).

i. Class B Biosolids: Biosolids meeting the vector attraction and meeting pollution concentration limits specified in 40 CFR Part 503 and pathogen reduction standards specified in 40 CFR Part 503.32(b).

j. Depth to Ground Water: The distance from the land surface elevation to the seasonal high water table.

k. Domestic Water Supply Well: A well that provides water used for human consumption.

l. EQ Biosolids: Biosolids which meet metals standards, Class A pathogen reduction standards, and vector attraction reduction standards contained in 40 CFR Part 503.13 (Table 3), 40 CFR Part 503.32, and 40 CFR Part 503.33, respectively.

m. Fertilizing Material: Biosolids with 5 percent or more of nitrogen, available phosphoric acid, or soluble potash, singly or in combination.

n. Generator: Municipal Wastewater Treatment Facility or Sewage Sludge Treatment Facility.

o. Grower: Person or entity primarily responsible for planting, maintaining, and harvesting or allowing the use of crops and/or range land for domestic animal or human use.

p. Gully erosion: Erosion cut by a concentrated but intermittent flow of water usually during and immediately following heavy rains or after ice/snow melt. A gully generally is an obstacle to wheeled vehicles and too deep (e.g., > 0.5 meter) to be obliterated by ordinary tillage.

q. High Potential for Public Exposure Areas: Land located within one-half mile of educational facilities, facilities designated for recreational activities other than hunting, fishing, or wildlife conservation, places of public assembly, hospitals, or similar sensitive receptors.

r. Horticulture: The practice, science, or art of cultivating the soil to produce fruit, vegetables, or ornamental plants for human use.

s. Key Operating Personnel: Those individuals responsible for the oversight of daily operations, management decisions, and planning of biosolids land application projects.

t. Low Potential for Public Exposure Areas: Land not meeting the definition of High Potential for Public Exposure Areas.

u. Label: The display of all written, printed, or graphic matter on the immediate container of, or a statement including the guaranteed analysis, accompanying fertilizing material as required by the California Department of Food and Agriculture.

v. Land Reclamation: The practice of revitalizing or restoring lands that are damaged from past or present human land use practices.

w. Long-Term Storage Facility: Site which holds biosolids for more than seven days consecutively.

x. Micronutrients: Refers to boron, chloride, cobalt, copper, iron, manganese, molybdenum, sodium, or zinc.

y. Municipal Wastewater Treatment Facilities (treatment facilities): Facilities designed to collect and treat wastewater generated from primarily domestic sources for environmentally safe reuse or disposal.

z. Notice of Applicability: Written notice that a biosolids land application site is required to comply with the provisions of this General Order and that applications according to the General Order may commence.

aa. Notice of Intent (NOI): Application for coverage under this General Order, as attached. The NOI is also a notification form for the public and interested parties for this General Order.

ab. Notice of Termination (NOT): Request form to discontinue coverage of this General Order.

ac. Nuisance: Nuisance means anything which meets all of the following requirements:

(1) Is injurious to health, or is indecent and offensive to the sense, or is an obstruction to the free use of property so as to interfere with the comfortable enjoyment of life and property.

(2) Affects at the same time an entire community or neighborhood or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.

(3) Occurs during, or as a result of, the treatment or disposal of wastes.

ad. Pathogens: Disease causing agents including helminths, bacteria, viruses, and protozoa.

ae. Pathogen Reduction: Process used to destroy pathogenic material contained in sewage sludge.

af. Pollution: Means an alteration of the quality of the waters of the State by waste to a degree which unreasonably affects either of the following:

(1) The waters for beneficial uses.

(2) Facilities which serve these beneficial uses.

ag. Secondary Nutrients: The elements of calcium, magnesium, and sulfur.

ah. Septage: Waste material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar wastewater handling device that has not passed through a municipal wastewater treatment facility.

ai. Sewage Sludge: The solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a municipal wastewater treatment facility. Sewage sludge includes solids removed or used during primary, secondary, or advanced wastewater treatment processes. Sewage sludge does not include grit or screening material generated during preliminary treatment of domestic sewage at a municipal wastewater treatment facility.

aj. Short-Term Storage: Biosolids storage sites used as a temporary holding facility for less than or equal to seven days.

ak. Silviculture: The practice, science, or art of managing, developing, and harvesting forests and trees for human use.

al. Soil Amendment: Applications of a fertilizing material or agricultural mineral for the purpose of promoting utilization by plants and other living organisms with the goal of a net gain in soil productivity.

am. Staging Area: Area used to hold biosolids for less than 48 hours prior to use for the specified activity listed in the NOI.

an. Tailwater: Excess water from crop irrigation resulting in a discharge off site to a surface water body.

ao. Vector Attraction: Characteristic of biosolids that attracts potential pathogen transmitters such as flies, rodents, and other animals or organisms.

ap. Water-saturated soil: Water content of the soil such that any further addition of water will result in runoff, standing water, or percolation of water through the displacement of existing soil water.

4. Treatment facilities serve urban and suburban population areas by collecting and treating municipal wastewater and reusing or disposing of wastewater effluent. While serving the public in this manner, significant amounts of sewage sludge are generated. This material is typically further

treated (stabilized) and dewatered and can be managed using a variety of options including: (a) disposal in a sanitary landfill, (b) incineration, (c) placement into a landfill dedicated for this purpose, (d) use as daily landfill cover, and (e) use in land application operations, including reclamation, horticulture, agriculture, and silviculture.

5. Particularly in urban areas, industrial sources discharge into wastewater collection systems. Many of these discharges are regulated by pretreatment programs implemented pursuant to 40 CFR Part 403. These programs restrict industries from discharging toxic pollutants in concentrations creating concerns for the treatment facilities.

6. As a result of domestic and industrial uses, pollutants enter the collection system of treatment facilities. The majority of the pollutant load treated at the treatment facilities is organic matter. This material is removed through flotation and/or settling or is converted to biological solids and then removed through settling prior to discharge. The settled material is then further treated to stabilize organic matter which constitutes the majority of the domestic sewage sludge. Metals from domestic and industrial sources are also present in the waste stream at the treatment facility. These pollutants are removed from the waste stream and concentrated in the sewage sludge. Organic chemicals can also be present from domestic and industrial uses of water. The fate of these pollutants is variable. Some are removed and destroyed through physical and biological processes at the treatment facility. Others may concentrate in the sewage sludge. Some pass through the treatment facilities unchanged and are subsequently discharged from the treatment process. A portion of the organic chemicals concentrated in the sewage sludge is degraded during sludge stabilization processes. Some organic chemicals can remain in the sewage sludge unchanged. For these reasons, testing of sewage sludge is necessary prior to it being classified as biosolids.

7. Biosolids are a source of organic matter, nitrogen, phosphorus, and micronutrients. These materials are beneficial to agriculture, silviculture, horticulture, and land reclamation activities and they improve agricultural productivity. More specifically, the benefits derived from biosolids used as a soil amendment are as follows:

    a. Nitrogen is a basic nutrient for plant growth. In biosolids, it is present in the forms of ammonia, nitrates, and organic nitrogen at concentrations from two to 10 percent by weight on a dry weight basis. The ammonia and nitrate forms of nitrogen are immediately available for plant usage. Organic nitrogen is released slowly (mineralized) over many months, providing a continuous supply of nitrogen for crops and minimizing the potential for movement of nitrogen to the ground water. The nitrogen available for plant usage at any given time is the sum of the ammonia, nitrate, and mineralized organic nitrogen.

    b. Phosphorus is a basic nutrient for plant growth and is present in all biosolids in varying concentrations.

c. Micronutrients, including a variety of salts and metals, are necessary for plant growth and are present in biosolids in varying amounts.
d. The addition of biosolids to soils can also be beneficial by enhancing soil structure, increasing water retention capability, promoting soil aggregation, and reducing the bulk density. Organic matter assists in maintaining soil pores which allow water and air to pass through the soil medium. Such pores can be lost at sites under continuous cultivation and they are critical in maintaining an aerobic environment within the plant root zone.

e. Organic matter helps soils retain water. Additional water retention can reduce the need for frequent water applications and can facilitate water conservation.

f. Liming agents are available when the biosolids have been chemically stabilized with lime. Liming agents increase soil pH and can improve the permeability of the soils. Higher pH soils have a greater propensity to bind most heavy metals, decreasing the chance of the metals migrating to the ground water.

8. Biosolids have the following characteristics which can create water quality and public health problems if improperly treated, managed, and regulated during use as a soil amendment:

a. Pathogens can be present. Unless the biosolids are specially treated or disinfected to destroy pathogens, significant concentrations of bacteria, viruses, and parasites can remain. Public health problems can be prevented with appropriate control over public access to the application areas and restrictions on the type and use of crops grown on the application sites. Buffer zones around water supply wells, surface water drainage courses, and public areas are designated to prevent transmission of pathogens to the public.

b. Heavy metals will be present. If heavy metals are over-applied to a field, they can cause ground water pollution, toxicity to plants, toxicity/adverse effects to soil microorganisms, or buildup in the plant tissues. A buildup of metals in plant tissues may allow transmission of the metals into the food chain which is the cause of toxicity/adverse effects to animals eating plants or animals containing elevated metals. Future cropping or other land uses could be restricted. Only some of the metals commonly found in biosolids are known to cause water quality or public health problems. Application rates for those metals have been established to avoid the problems.

c. Nitrogen can be over-applied, allowing a buildup of nitrogen in soils. Excess nitrogen will eventually be converted to the nitrate form and it can migrate to ground water. Excess nitrate in the ground water can result in the exceedance of drinking water standards and a public health threat. Nitrogen over-application can be prevented by biosolids application at an agronomic rate, that is, by matching the application rate of the nitrogen to the nitrogen usage rate of the crops and to soil permeability and soil retention capability.

d. Odor and insect nuisances can be caused if the biosolids have not been adequately treated (stabilized) prior to application or if wet biosolids are allowed to remain on the ground surface for several days. Compliance with State and federal standards for stabilization of the biosolids will minimize the potential for odors and insect nuisances. Proper management at the application site will prevent odor or insect nuisances. Properly stabilized biosolids will generate limited, transient odors in the immediate vicinity of the application operations. Adequate buffer zones around residences and public areas, therefore, should be provided.

e. Discharge of organic matter, metals, and pathogens to surface waters can affect water quality. These effects can be prevented by controlling field runoff. The water quality threat of organic matter of biosolids origin affecting surface water is no greater than for a similar quantity of other organic soil amendments.

9. The U. S. Environmental Protection Agency (USEPA) has promulgated 40 CFR Part 503 for the use of biosolids as a soil amendment. These regulations establish ceiling concentrations for metals and pathogen and vector attraction reduction standards; management criteria for the protection of water quality and public health; and annual and cumulative discharge limitations of persistent pollutants, such as heavy metals, to land for the protection of livestock, crop, and human health and water quality protection. The requirements of 40 CFR Part 503 are based on a risk-based evaluation using 14 different pathways.

10. The National Research Council established a committee to review the methods and procedures used by the USEPA while forming the basis of the 40 CFR Part 503. The National Research Council's members are drawn from the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. Committee members included university professors from the schools of law, science, and agriculture; a state health official; a food industry professional; a professional from a sanitation agency; and a professional consultant. After a three-year study (starting in 1993), the committee made some recommendations for improvement of the regulations and data from which they are based but also stated: "Established numerical limits on concentration levels of pollutants added to cropland by sludge are adequate to assure the safety of crops produced for human consumption." As a result of the peer review, monitoring for organic chemicals and using fecal coliform testing as a parameter for determining Class A level pathogen reductions is included in this General Order.

11. Due to the extensive work done by the USEPA, this General Order is using the 40 CFR Part 503 requirements as baseline requirements for compliance. However, this General Order is applicable to sites where biosolids are applied to land and is not intended to solely regulate the generator (unless the generator is also the landowner or land applier). The 40 CFR Part 503 requirements are only intended for and enforceable against the generator. Therefore, this General Order does not constitute compliance with 40 CFR Part 503. Since the SWRCB is not delegated with authority for the Federal Biosolids Program, the USEPA is the only authority to determine compliance with 40 CFR Part 503.

12. Each discharger covered by this General Order shall submit an annual fee and an application fee equal to the annual fee, pursuant to CWC section 13260. The amount of the fee is currently determined by the type of order issued the threat to water quality, and complexity of the specific discharge, as detailed in Section 2200, Chapter 9, Division 3, Title 23, California Code of Regulations (CCR). Biosolids application projects greater than 40 acres are deemed as Non-Chapter 15 WDRs with a Category "II" threat to water quality rating and a Category "b" complexity rating. Biosolids projects consisting of less than 40 acres are deemed Category "III" threat to water quality rating and a Category "b" complexity rating.

13. This General Order may be periodically revised to reflect changes in federal or State laws or regulations or policies of the SWRCB or RWQCB.

14. Under CWC section 13263, the SWRCB can prescribe General WDRs for categories of discharges which involve the same or similar waste type or those which are produced by the same or similar operations.

15. This General Order shall primarily apply to both the landowner of sites using biosolids and the biosolids generator, but may also include, as determined by those involved in the operation, the individuals, or companies, transporting and placing the biosolids in the field and the land lessee in conjunction with the landowner and the generator. To obtain coverage under the General Order, a complete NOI and an appropriate fee must be submitted to the RWQCB. Once a completed application is submitted, RWQCB staff will evaluate the project to determine if it is suitable for regulation under this General Order and the corresponding California Environmental Quality Act (CEQA) document. Only after a determination of applicability is made will the discharger be issued a Notice of Applicability by the RWQCB Executive Officer. Only applicants (dischargers) who submit a complete NOI, appropriate fee, and are issued a Notice of Applicability are authorized to land apply biosolids at an agricultural, horticultural, silvicultural, or land reclamation site as a soil amendment onto the land specified in the NOI in compliance with the terms and conditions of this General Order. If it is determined that a local agency already adequately regulates the activity subject to this permit, the RWQCB may choose not to issue this General Order in order to avoid any duplicative regulation.

16. A separate NOI and filing fee must be filed for each biosolids use project to be eligible for coverage under this General Order. A separate NOI and filing fee must be filed for each landowner involved in a reuse project. Attachment A to this General Order contains an NOI form which details the minimum contents of the NOI. A single reuse project will be limited to sites comprising not more than
2,000 net acres available for application. Net acreage is the land available for application, excluding roads, surface water drainage, and required buffer areas. The sites comprising a single reuse project shall be contained within a ten-mile radius of a given location. There is no restriction on the number of NOIs which may be filed for reuse within any geographic area. A single reuse project may be a one-time application or may be repetitive applications to the same

parcel. Filing fees are annual fees. Projects will be billed for an annual fee equaling the filing fee until the project is completed and coverage under the General Order has been terminated.

17. This General Order sets minimum standards for the use of biosolids as agricultural, horticultural, silvicultural, or reclamation site soil amendments, and it does not preempt or supersede the authority of local agencies to prohibit, restrict, or control the use of biosolids subject to their control, as allowed under current law. It is the responsibility of the discharger to make inquiry and to obtain any local governmental agency permits or authorizations prior to the application of biosolids at each site.

18. Some areas in California have been designated as unique and valuable public resources. Such areas have been defined in the State law and the CCR as jurisdictional waters or preserves or have been addressed through acts specifically intended to preserve and manage the resource. This General Order is not applicable to those areas as described below:

    a. The Lake Tahoe Basin.

    b. The Santa Monica Mountains Zone as defined by section 33105 of the Government Code.

    c. The California Coastal Zone, as defined in and mapped pursuant to Public Resources Code (PRC) section 30103.

    d. An area within one quarter mile of a wild and scenic river, as defined by PRC section 5093.5.

    e. The Sacramento-San Joaquin Delta, as defined in CWC section 12220.

    f. The Suisun Marsh, as defined in (PRC) section 29101.

    g. The jurisdiction of the San Francisco Bay Conservation and Development Commission, as defined in Government Code section 66610.

    h. The following prohibition areas contained in the Water Quality Control Plan[1] of the Lahontan RWQCB:

        (1) Glenshire and Devonshire Subdivisions, Town of Truckee

        (2) Areas southwest of Piute Creek and north of Susan River and included in Sections 21, 25, 26, 27, 28, 33, 34, 35, and 36, T30N, R11E, MDB&M

[1] A detailed description of the prohibition areas can be found in the Lahontan RWQCB's Wate Quality Control Plan (Basin Plan)

(3) Eagle Lake Basin-Spaulding Tract, Stones-Bengard Subdivision, and Eagle's Nest Summer Home Tract

(4) Mono-Owens Planning Area

(a) Rush Creek Watershed above the outlet of Grant Lake

(b) Mammoth Creek Watershed, including the drainage area of the community of Mammoth Lake, and the Sherwin Creek Watershed upstream of the confluence of Sherwin and Mammoth Creeks

(c) Inyo County Service Area No. 1

i. Assessment District No. 1
ii. Assessment District No. 2
iii. Rocking K Subdivision
iv. City of Bishop

(5) Antelope Valley Planning Area

(a)The Antelope Hydrologic Unit above an elevation of 3,500 feet

(6) Mojave River Planning Area

(a) The Silverwood Lake Watershed

(b) The Deep Creek Watershed above an elevation of 3,200 feet

(c) The Grass Valley Creek Watershed above an elevation of 3,200 feet

(d) Area north of State Highway 18 within the area commonly known as Apple Valley and Desert Knolls

(7) Hilton Creek/Crowley Lake communities

19. The biosolids applied to land under this General Order are non-hazardous decomposable wastes applied as a soil amendment pursuant to best management practices and, as such, are exempt from the requirements of Title 23, CCR, Section 2510, et seq., (Chapter 15), in accordance with Section 2511(f).

20. The construction and use of biosolids storage facilities allowed by this General Order are for short-term storage of biosolids in the event that biosolids cannot be immediately applied to the

ground surface because of an unanticipated event, such as mechanical breakdown of equipment or an unseasonable rainstorm. Because of the short period of storage allowed by this General Order, the stockpiled biosolids are not a threat to the quality of underlying ground water; thus, the storage basins need not be regulated as either a waste pile or surface impoundment under Title 27 of the CCR. If long-term storage is proposed, the discharger will need to apply for a separate WDR for the long-term biosolids storage facility. Biosolids application to land associated with a project using a permitted long-term biosolids storage basin may be conducted under this General Order, if appropriate.

21. Ground water and surface waters of California have been evaluated for their maximum potential beneficial uses. Those use categories are discussed below:

    a. The designated beneficial uses of surface waters within the State are:

        (1) Municipal Supply (MUN)
        (2) Agricultural Supply (AGR)
        (3) Aquaculture (AQUA)
        (4) Fresh Water Replenishment of Salton Sea (FRSH)
        (5) Industrial Service Supply (IND)
        (6) Ground Water Recharge (GWR)
        (7) Water Contact Recreation (REC I)
        (8) Noncontact Water Recreation (REC II)
        (9) Warm Water Habitat (WARM)
        (10) Cold Freshwater Habitat (COLD)
        (11) Wildlife Habitat (WILD)
        (12) Hydropower Generation (POW)
        (13) Preservation of Rare, Endangered, or Threatened Species (RARE)

    b. The designated beneficial uses of ground waters in California are:

        (1) MUN
        (2) IND(3) AGR
        (4) AQUA
        (5) WILD

    Some ground water and surface waters have fewer beneficial uses. Beneficial uses for specific water bodies can be found in the applicable RWQCB's Water Quality Control Plan (Basin Plan).

22. On _____, in accordance with CEQA (PRC, Section 21000, et seq.), the SWRCB adopted a Mitigated Environmental Impact Report No._____for these General WDRs.

23. The SWRCB has notified all known interested agencies and persons of its intent to prescribe General WDRs for the reuse of biosolids as a soil amendment and has provided them with an opportunity for a public hearing and an opportunity to submit comments.

24. The SWRCB, in a public meeting on_____, heard and considered all comments pertaining to the General Order.

**IT IS HEREBY ORDERED** that all dischargers that file an NOI indicating their intention to be regulated under provisions of this General Order, and all heirs, successors, or designees, in order to meet the provisions contained in Division 7 of CWC and regulations adopted thereunder, shall comply with the following:

A. PROHIBITIONS

1. The discharge of biosolids is prohibited unless the discharger has submitted an NOI, filing fee, and a pre-application report and in response to these submittals, the RWQCB has issued a Notice of Applicability, individual WDRs, or a waiver of WDRs for the discharge.

2. Applications of biosolids shall be confined to the designated use areas stated and shown in the NOI and pre-application report.

3. The discharge shall not cause or threaten to cause pollution, as defined in CWC section 13050.

4. The application of any material that results in a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code section 25249.5) is prohibited.

5. The storage, transport, or application of biosolids shall not cause a nuisance, as defined in CWC section 13050.

6. There shall be no discharge of biosolids from the storage or application areas to adjacent land areas not regulated by this General Order, to surface waters, or to surface water drainage courses.

7. From the permitted site, irrigation water runoff is prohibited for 30 days after application of biosolids if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation to prevent the movement of biosolids from the application site.

8. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation or at rates that would degrade ground water is prohibited except as allowed by Prohibition A.9.

9. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation may be allowed for soil reclamation projects (as defined by land reclamation on page 7) as part of an overall plan for reclamation of sites (such as abandoned mine tailings and gravel quarries), provided the discharger can demonstrate that the application of excess nitrogen will not result in unacceptable degradation of underlying ground waters. A report prepared by a Certified Agronomist, Certified Soil Scientist, Registered Agricultural Engineer, or Registered Civil Engineer providing this demonstration shall be submitted to and approved by the RWQCB Executive Officer prior to the application of biosolids to reclamation sites at greater than agronomic rates.

10. The discharge of biosolids except as allowed for authorized storage, processing, and application sites is prohibited.

11. The application of "hazardous waste," as defined in Chapter 11, Division 4.5, Title 22 of the CCR, is prohibited.

12. Discharge of biosolids with pollutant concentrations greater than those shown below is prohibited.

| | Ceiling Concentration |
|---|---|
| Constituent | mg/kg dry weight |
| | |
| Arsenic | 75 |
| Cadmium | 85 |
| | |
| Copper | 2,500 |
| Lead | 350 |
| Mercury | 57 |
| Molybdenum | 75 |
| Nickel | 420 |
| Selenium | 100 |
| Zinc | 7,500 |

13. The application of biosolids to water-saturated or frozen ground or during periods of precipitation that induces runoff from the permitted site is prohibited.

14. The application of biosolids containing a moisture content of less than

50 percent is prohibited. .

15. The application of biosolids in areas where biosolids are subject to gully erosion or washout off site is prohibited.

16. The application of biosolids to slopes exceeding 25 percent is prohibited.

B. DISCHARGE SPECIFICATIONS

1. All biosolids subject to this General Order shall comply with the applicable pathogen reduction standards listed in 40 CFR Part 503.32. In addition to those standards, all biosolids meeting Class A standards shall not have a maximum fecal coliform concentration greater than 1,000 most probable number (MPN) per gram of biosolids; or the density of salmonella, sp.[2] shall not be greater than three MPN per four grams.

2. All biosolids subject to this order shall comply with one of the applicable vector attraction reduction requirements specified in 40 CFR Part 503.33.

3. Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed by Prohibition No. 9 or for biosolids research projects.

4. Biosolids shall not be applied in amounts exceeding the Risk Assessment Acceptable Soil Concentration as described below:

$$BC = RP - 1.78(BS)$$

Where: BC= Background Cumulative Adjusted Loading Rate (Lbs./Acre)
RP = 40 CFR Part 503 Cumulative Pollutant Loading Rate (Lbs./Acre)
BS = Actual Site Background Site Soil Concentration (mg/Kg)

And Where the Values for RP on a pollutant specific basis are given below:

| Pollutant | Cumulative Pollutant Loading Rate (RP) (Lbs./Acre) |
|---|---|
| | |
| Arsenic | 36 |
| Cadmium | 34 |

[2] As determined by a USEPA approved method other than a method listed in "Standard Methods for the Examination of Water and Wastewater" 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW., Washington, DC 2005; and other than the method found in Kenner, B. A. and H. P. Clark, "Detection and Enumeration of Salmonella and Pseudomonas aeruginosa," Journal of Water Pollution Control Federation, Vol. 46, No. 9, September 1974, pp. 2163-2171. Water Environment Federation, Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314.

| | |
|---|---|
| Copper | 1336 |
| Lead | 267 |
| Mercury | 15 |
| Molybdenum | 16 |
| Nickel | 374 |
| Selenium | 89 |
| Zinc | 2,494 |

5. If biosolids are applied to a site where the soil will be tilled, biosolids shall be incorporated within 24 hours after application in arid areas and within 48 hours in non-arid areas. Tillage practices shall be used which minimize the erosion of soils from the application site by wind, storm water, or irrigation water.

6. If biosolids are applied to ground surfaces having a slope greater than ten percent (10%) or if required by the RWQCB Executive Officer, a report, including an erosion control plan, shall be prepared by a Certified Soil Scientist, Certified Agronomist, Registered Agricultural Engineer, Registered Civil Engineer, or a Certified Professional Erosion and Sediment Control Specialist and submitted to the RWQCB for approval with the NOI. This report shall describe the site conditions that justify application of biosolids to the steeper slopes and shall specify the application and management practices necessary (a) to assure containment of the biosolids on the application site and (b) to prevent soil erosion.

7. Structures conveying tail water shall be designed and maintained to minimize any field erosion. Tail water structures shall be boarded and wrapped with plastic prior to any biosolids application but removed after biosolids incorporation into the soil.

8. Biosolids distinguished as "Class B" in 40 CFR Part 503 must comply with the following:

   a. The discharge of tail water or field runoff is prohibited within 30 days after application of biosolids for areas where biosolids have not been incorporated into the soil and where there is not a minimum of 33 feet of unmowed grass or similar vegetation bordering the application area and along the path of runoff to prevent movement of biosolids particles from the application site.

   b. After an application of biosolids in any field, the discharger shall ensure the following:

      (1) For at least 30 days:

         (a) Public access to the application sites is restricted for sites with a low potential for public exposure;
         (b) Food, feed, and fiber crops are not harvested; and
         (c) Animals are not grazed.

(2) For at least 12 months:

(a) Public access to the site is restricted for sites with a high potential for public exposure;
(b) Turf is not to be harvested if the harvested turf is placed on land with a high potential for contact by the public as defined in 40 CFR Part 503.11; and
(c) Grazing of milking animals used for producing unpasteurized milk for human consumption is prevented if the field is used as pasture.

(3) For at least 14 months:

Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface are not harvested.

(4) For at least 20 months:

Food crops with harvested parts below the land surface are not harvested when the biosolids remain exposed on the surface for four months or longer prior to incorporation.

(5) For at least 38 months:

Food crops with harvested parts below the land surface are not harvested when the biosolids remained exposed on the ground surface for less than four months prior to incorporation into the soil.

9. Staging and biosolids application areas shall be at least:

a. 10 feet from property lines,
b. 500 feet[3] from domestic water supply wells,
c. 100 feet[4] from non-domestic water supply wells,
d. 50 feet from public roads and occupied onsite residences[5],
e. 100 feet from surface waters[6], including wetlands, creeks, ponds, lakes, underground aqueducts, and marshes,

[3] For sites where the topography slopes are greater than 10 percent, the minimum width of vegetative border shall be proposed in accordance to Discharge Specification No. 6 above.
[4] A lesser setback distance from domestic supply wells (not to be less than 100 feet) may be used if the discharger can demonstrate to the Executive Officer that the ground water, geologic, topographic, and well construction conditions at the specific site are adequate to protect the health of individuals using the supply well.
[5] A lesser setback distance (not to be less than 25 feet) may be used if the discharger can demonstrate to the RWQCB Executive Officer that the ground water, geologic, topographic, and well construction conditions at the specific site are adequate to protect the ground water. Not including agricultural drains.

f. 33 feet from primary agricultural drainage ways,
g. 500[7] feet from occupied non-agricultural buildings and off-site residences,
h. 400 feet from a domestic water supply reservoir,
i. 200 feet from a primary tributary to a domestic water supply, and
j. 2,500 feet from any domestic surface water supply intake.

C. BIOSOLIDS STORAGE AND TRANSPORTATION SPECIFICATIONS

Biosolids shall be considered to be "stored" if they are placed on the ground or in non-mobile containers (i.e., not in a truck or trailer) at the application site or an intermediate storage location away from the generator/processing for more than
48 hours. Biosolids shall be considered to be "staged" if placed on the ground for brief periods of time solely to facilitate transfer of the biosolids between transportation and application vehicles.

1. Biosolids shall not be stored for more than seven (7) consecutive days prior to application.

2. Biosolids containing free liquids shall not be placed on the ground prior to application on an approved site, excluding equipment cleaning operations.

3. Biosolids shall not be stored directly on the ground at any one location for more than seven (7) consecutive days.

4. Sites for the storage of Class B biosolids shall be located, designed, and maintained to restrict public access to the biosolids.

5. Biosolids storage facilities that contain biosolids between October 1 and April 30 shall be designed and maintained to prevent washout or inundation from a storm or flood with a return frequency of 100 years.

6. Biosolids placed on site for more than 24 hours shall be covered.

7. Biosolids storage facilities shall be designed, maintained, and operated to minimize the generation of leachate and the effects of erosion.

8. If biosolids are to be stored at the site, a plan describing the storage program and means of complying with this General Order shall be submitted for RWQCB Executive Officer approval with the NOI. The storage plan shall also include an adverse weather plan.

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[6] Applies to biosolids storage facilities at the reuse site, not biosolids storage facilites which are part of a wastewater treatment plant or which are covered by separate WDRs.

[7] Applications in a such proximity to on site residences must be approved by the resident.

9. The discharger shall operate the biosolids storage facilities in accordance with the approved biosolids storage plan.

10. The discharger shall immediately remove and relocate any biosolids stored or applied on site in violation of this General Order.

11. All biosolids shall be transported in covered vehicles capable of containing the designated load.

12. All biosolids having a water content that is capable of leaching liquids shall be transported in leak proof vehicles.

13. Each biosolids transport driver shall be trained as to the nature of its load and the proper response to accidents or spill events and shall carry a copy of an approved spill response plan.

D. PROVISIONS

1. To obtain coverage under this General Order and terminate coverage thereof, the following must take place:

   a. Coverage:

      A complete NOI form and filing fee must be filed by the discharger for each proposed application site covered by these General WDRs. The NOI form may be modified by the RWQCB Executive Officer as the need arises. An NOI form is attached (Attachment A) to this General Order. Coverage does not begin until a Notice of Applicability has been issued by the applicable RWQCB's Executive Officer. No discharge shall occur until 15 days after submission of the Pre-Application Report as required in the Monitoring and Reporting Program.

   b. Coverage Termination:

      (1) A biosolids application project covered by these General WDRs may be terminated by submittal of the Final Monitoring and Reporting Program technical report and an NOT, as shown on Attachment B of these General WDRs. The discharger(s) will be responsible for paying all annual fees for coverage under these General WDRs until approval of the NOT is granted by the RWQCB Executive Officer. For sites using Class B biosolids, termination shall not take place until 38 months after the last Class B biosolids application. The NOT form may be modified by the RWQCB Executive Officer as the need arises.

(2) If an individual WDR Order is issued to the discharger for a project covered by this General Order, the applicability of this General Order to the discharger is automatically terminated on the effective date of the individual WDR Order.

2. Where ground water monitoring is required, as specified by the RWQCB Executive Officer or as contained in Monitoring and Reporting Program, the ground water monitoring program must be in place prior to any application of biosolids.

3. The discharger shall submit copies of each NOI to the appropriate regional office(s) of the Department of Fish and Game, local water district, City Planning Department, County Health Department(s), County Planning Department(s), and County Agricultural Commissioner(s) with jurisdiction over the proposed application site(s). Also, the discharger shall notify adjacent property owners with parcels abutting the subject land application site and, where applicable, tenants. The discharger shall submit proof to the RWQCB that all the above agencies and persons were notified. Other than compliance evaluations, the RWQCB is not responsible for the notification process.

4. The discharger shall comply with the Monitoring and Reporting Program No. 2000- which is part of this General Order and any plans required and contained within, and any revisions thereto.

5. The discharger must notify the RWQCB Executive Officer in writing at least 30 days in advance of any proposed transfer of this General Order's responsibility and coverage to a new discharger. The notice must include a new NOI for the proposed discharger, an NOT for the existing discharger, and a specific date for the transfer of this General Order's responsibility. This agreement shall include an acknowledgment that the existing discharger is liable for compliance with this General Order and for all violations up to the transfer date and that the new discharger is liable for compliance with this General Order and all violations after the transfer date.

6. Where the discharger becomes aware that it failed to submit any relevant facts in an NOI or submitted incorrect information in an NOI or in any report to the RWQCB, it shall promptly submit such facts or information.

7. The discharger shall be responsible for informing all biosolids transporters, appliers, and growers using the site of the conditions contained in this General Order.

8. The discharger must comply with all conditions of this General Order, including timely submittal of technical and monitoring reports as directed by the RWQCB Executive Officer. Violations may result in enforcement action, including RWQCB or court orders requiring corrective action or imposing civil monetary liability or revision or rescission of the applicability of this General Order to a specific project.

9. Individuals and companies responsible for site operations retain primary responsibility for compliance with these requirements, including day-to-day operations and monitoring. Individual property owners and property managers retain primary responsibility for crop selection and any access or harvesting restrictions resulting from biosolids application. Individual owners of the real property at which the discharge will occur are ultimately responsible for ensuring compliance with these requirements. Enforcement actions for violations of this General Order may be taken against all dischargers required to comply with this General Order.

10. A copy of this General Order shall be kept at the discharge facility for reference by operating personnel. Key operating personnel shall be familiar with its contents.
11. This General Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, do not protect the discharger from his liability under federal, State, or local laws, nor do they create a vested right for the discharger to continue the waste discharge.

12. Provisions of these WDRs are severable. If any provision of these requirements is found invalid, the remainder of these requirements shall not be affected.

13. The SWRCB will review this General Order periodically and will revise requirements when necessary.

14. The discharger at all times shall properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with conditions of this General Order. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of this General Order.

15. The discharger shall allow the RWQCB or an authorized representative upon the presentation of credentials, valid identification with photograph, and other documents as may be required by law to:

    a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this General Order;
    b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Order;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Order; and

d. Sample or monitor at reasonable times, any substances or parameters at any location for the purposes of assuring compliance with this General Order or as otherwise authorized by the CWC.

16. All monitoring instruments and devices used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy. All measurement devices shall be calibrated at least once per year or more frequently to ensure continued accuracy of the devices.

    Unless otherwise permitted by the RWQCB Executive Officer, all analyses shall be conducted at a laboratory certified for such analyses by the California Department of Health Services. The RWQCB Executive Officer may allow use of any uncertified laboratory under exceptional circumstances, such as when the closest laboratory to the monitoring location is outside the State boundaries and therefore is not subject to certification. All analyses shall be conducted in accordance with those methods specified in 40 CFR Part 503.8(1) through 40 CFR Part 503.8(4), 40 CFR Part 503.8(6), and 40 CFR Part 503.8(7).

17. The discharger shall report any noncompliance which may endanger human health or the environment. Any such information shall be provided orally to the RWQCB Executive Officer within 24 hours from the time the discharger becomes aware of the circumstances. A written submission shall also be provided within five days of the time the discharger becomes aware of the circumstances. The written submission shall contain (a) a description of the noncompliance and its cause; (b) the period of noncompliance, including exact dates and times; and, (c) if the noncompliance has not been corrected, the anticipated time the noncompliance is expected to continue and steps being taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance with a time schedule that includes milestone dates. The RWQCB Executive Officer or an authorized representative may waive the written report on a case-by-case basis if the oral report has been received within 24 hours. Also, the discharger shall notify the Office of Emergency Services (1-800-852-7550), the State Department of Health Services, Food and Drug Branch, (916) 445-2263), and the local health department as soon as practical but within 24 hours after the incident.

18. The discharger shall retain records of all monitoring information including all calibration and maintenance records for on-site monitoring equipment (if applicable), copies of all reports required by this General Order, and records of all data used to complete the application for this General Order. Records shall be maintained for a minimum of three years from the date of the sample, measurement, report, or application. This period may

be extended during the course of any unresolved litigation regarding this discharge or when requested by the RWQCB Executive Officer.

Records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical techniques or methods used; and
f. The results of such analyses.

19. All application reports or information to be submitted to the RWQCB Executive Officer shall be signed and certified as follows:

    a. For a corporation--by a principal executive officer or at least the level of vice president.
    b. For a partnership or sole proprietorship--by a general partner or the proprietor, respectively.
    c. For a municipality, State, federal, or other public agency--by either a principal executive officer or ranking elected official.

20. A duly authorized representative of a person designated in Provision No. 19 of this provision may sign documents if:

    a. The authorization is made in writing by a person described in Provision No. 19, above.
    b. The authorization specifies either an individual or position having responsibility for the overall operation of the regulated facility or activity; and
    c. The written authorization is submitted to the RWQCB Executive Officer.

Any person signing a document under these Provisions shall make the following certification:

> "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on _____.

AYE:

NO:

ABSENT:

ABSTAIN:

_____
Maureen Marché
Administrative Assistant to the Board

STATE WATER RESOURCES CONTROL BOARD
MONITORING AND REPORTING PROGRAM NO. 2000-DWQ
GENERAL WASTE DISCHARGE REQUIREMENTS (WDRs) FOR THE
DISCHARGE OF BIOSOLIDS TO LAND FOR USE IN AGRICULTURAL,
SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES

PRE-APPLICATION REPORT

As required in Provision 1.a. of the General Order, a Pre-Application Report shall be submitted for each field or distinct application area prior to the application of biosolids in accordance with the WDRs. Where biosolids are applied on a continuing basis to a single area, the Pre-Application Report may cover ongoing operations and may not need to be submitted for each load applied. A pre-application report should be submitted 15 days prior to the date of the proposed application. The Pre-Application Report shall be signed by the owner/operator of the biosolids application operation and by the property owner. The property owner may submit written authorization to allow a representative of the property owner, such as a tenant or land management company, to sign the Pre-Application Report.

Information in the Pre-Application Report found in **bold type** is a required field to be submitted in the Pre-Application Report. Otherwise, information that was submitted in the Notice of Intent (NOI) and has not changed or will not change is not required. The following items shall be included in the Pre-Application Report and shall be submitted to the appropriate Regional Water Quality Control Board (RWQCB):

**Waste Discharge Identification System No._____**

This number is established at the time the initial Notice of Intent (NOI) is submitted to the RWQCB and can be obtained at the RWQCB.

1. Site Location/Applier Information-A separate Pre-Application Report must be completed for each different site.

| | |
|---|---|
| **Landowner:** | |
| **Address:** | |
| **Contact:** | **Phone:** |
| **Site Location (including address, if any):** | |
| **Nearest Cross Street(s):** | |
| **County:** | **Total Size of Site** |
| **Section(s)/Township/Range/Meridian:** | |
| **Latitude (from field center):** | **Longitude (from field center):** |

| | |
|---|---|
| **Applier** | |
| **Address:** | |
| **Contact:** | **Phone:** |

Attach a U.S. Geological Survey 7.5 Minute map or similar map (1:24000 or larger) showing the proposed application site and surrounding properties within 2,500 feet from site boundaries. The map should show:

a. Site topography
b. Run-on/runoff controls
c. Storage areas
d. Nearby surface waters, wells, residences, and public roads
e. Application area(s) including buffer zones (setbacks)
f. Ground water monitoring wells (if required)
g. Elevation

2. **Biosolids Source**-- The section below must be completed **for each source of biosolids**. If additional space is required, copy this section and attach.

| | | | | |
|---|---|---|---|---|
| **Wastewater Treatment Plant** | | | | |
| **Mailing Address** | | | | |
| **City** | **County** | **Zip** | **State** | **Phone** |
| **Contact Person** | | | | |

**Level of Pathogen Treatment: Class A_____ Class B_____**
**Description of vector attraction reduction achieve**ment:
_____

3. **Constituent Concentrations (Each Source)**

| **Constituent** | **Concentration in Biosolids, mg/kg, dry weight** | |
|---|---|---|
| **Arsenic** | | |
| **Cadmium** | | |
| | | |
| **Copper** | | |

| Constituent | Concentration in Biosolids, mg/kg, dry weight | |
|---|---|---|
| **Lead** | | |
| **Mercury** | | |
| **Molybdenum** | | |
| **Nickel** | | |
| **Selenium** | | |
| **Zinc** | | |
| **pH** | | |
| **Salinity** | | |
| **Total Solids Content** | **%** | |
| **Total Nitrogen** | | |
| **Fecal Coliform (if applicable)** | **MPN/gram** | |
| **Ammonia Nitrogen, as N** | | |
| **Total Phosphorus, as P**<br>**Total Potassium** | | |
| **SW 846[1] Method 8080 for PCB Aroclors, Aldrin/Dieldrin** | | |
| **EPA Method 8270 Semi-Volatile Organics** | | |

**Date samples collected** _____ _____
**Date samples analyzed** _____ _____
**Attach copies of all lab reports.**

4. **Application Area Information**

| Subject | Value | Applicable Unit/ Type of Measure |
|---|---|---|
| **Quantity of Biosolids to be Applied** | | |
| **Land Use Zone** | | |
| **Adjacent Land Use Zones** | | |
| **Application Area Size** | | Acres |
| **Proposed Nitrogen Loading** | | Lb. plant available nitrogen/acre |
| **Residual Nitrogen from** | | Lb. per acre |

[1] The Discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

| Subject | Value | Applicable Unit/ Type of Measure |
|---|---|---|
| **Previous Fertilizer and Biosolids Applications**[2] | | |
| **Proposed Crop, Use** | | Crop type, human/animal/neither |
| **Crop Nitrogen Usage** | | Lb. nitrogen/acre/year |
| **Nitrogen Usage Reference** | | |
| **Anticipated Average Application Rate** | | Dry tons/application |
| **Average Annual Precipitation** | | Inches/year |

Attach an anticipated annual time schedule for the field operations including anticipated biosolids applications windows, seeding operations, supplemental fertilization, and cultivation/harvest.

5. **Ground Water Monitoring**

For biosolids application operations where minimum depth to usable ground water[3] is less than 25 feet or as specified by the RWQCB Executive Officer and where special circumstances would warrant ground water monitoring, a ground water monitoring program, at a minimum, shall consist of three monitoring wells (one up gradient, two down gradient) for each application area and shall be in place prior to any application of biosolids if the discharger intends to or does apply biosolids more than twice within a five-year period at any particular location. A report specifying location, construction, and development details of ground water monitoring wells shall be submitted to the RWQCB for approval by the RWQCB Executive Officer prior to the installation. In addition, a mean sea level (MSL) reference elevation shall be established for each well in order to determine water elevations. The RWQCB Executive Officer, after reviewing the information submitted, may waive this requirement if it is determined that the benefit of such monitoring is not commensurate to the level of protection.

Results shall be submitted to the RWQCB 30 days prior to any biosolids application at each site and annually thereafter. Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameters:

| Parameter | Units |
|---|---|
| Static Water Level | feet (MSL) |
| Total Dissolved Solids | mg/L |

[2] Attach a sheet showing calculations and all assumptions used for calculating residual Nitrogen from previous fertilizer and biosolids applications.

[3] Usable ground water: Ground water is defined as having either an agricultural or domestic supply source as described in the RWQCB Basin Plan.

| | |
|---|---|
| Sodium | mg/L |
| Chloride | mg/L |
| Nitrate | mg/L as N |
| Total Nitrogen | mg/L as N |
| pH | pH units |

Initial testing shall also include the following parameters:

| | |
|---|---|
| Arsenic | mg/L |
| Cadmium | mg/L |
| Copper | mg/L |
| Lead | mg/L |
| Mercury | mg/L |
| Molybdenum | mg/L |
| Nickel | mg/L |
| Selenium | mg/L |
| Zinc | mg/L |

6. Biosolids Storage Plan (as required by Storage and Transportation Spec. No. 8)A biosolids storage plan must be attached (even if no *on-site* biosolids storage will be provided). The biosolids storage plan should include at a minimum:

   If on-site storage will be provided:

   a. Size of biosolids storage area
   b. How frequently it will be used (emergency basis only or routine use)
   c. Leachate controls
   d. Erosion controls
   e. Run-on/runoff controls

   If no on-site storage will be provided:

   a. Location of off-site storage facilities
   b. Emergency storage plans

7. **Erosion Control Plan (as required by Discharge Specification No. 6))**

   Biosolids applied to ground surfaces having a 10 percent or greater slope requires an Erosion Control Plan. The Plan should outline conditions that justify application of biosolids to the 10 percent or greater slopes and specify the application and management practices to be used to assure containment of the biosolids on the application site.

8. **Spill Response and Traffic Plan (as required by Biosolids Storage and Transportation Specification No. 13)**

a. The Spill Response Plan should include at a minimum:

(1) Emergency contacts and notification procedures
(2) Personal protective equipment requirements.
(3) Response instructions for spill during biosolids transport.
(4) Response instructions for storage facility failure.
(5) Response instructions if hazardous or other unauthorized material is found.

b. The Traffic Plan should include at a minimum:

(1) The proposed route for all vehicles handling biosolids.
(2) The anticipated maximum vehicle weight.

## 9. Adverse Weather and Alternative Plan

Submit an Adverse Weather and Alternative Plan that details procedures to address times when biosolids cannot be applied to the site(s) due to adverse weather or other conditions (wind, precipitation, field preparation delays, access road limitations, etc.).

## ANNUAL REPORTING

1. **Ground Water Monitoring** (if required in the Pre-Application Report)

Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameters:

| Parameter | Units |
|---|---|
| Static Water Level | feet (MSL) |
| Total Dissolved Solids | mg/1 |
| Sodium | mg/1 |
| Chloride | mg/1 |
| Nitrate | mg/1 as N |
| Total Nitrogen | mg/1 as N |
| pH | pH units |

2. **Application Information**

| | | |
|---|---|---|
| Quantity of Biosolids Applied | | Dry tons |
| Application Area Size | | Acres |
| Total Nitrogen Concentration in Biosolids | | mg/kg |
| Nitrogen Loading | | Lb. plant avail. Nitrogen per acre |
| Residual Nitrogen[4] | | Lbs. per acre |
| Crop | | |
| Amount of Crop Produced | | Specify units |

3. **Pollutant Loadings for Each Application Site**

| Pollutant | Total Loadings from Previous Years (kg/ha) | Loading This Year (kg/ha) | Background Soils Conc. (kg/ha) (6" depth) | Cumulative Metal Load to Date (kg/ha) | Percent Cumulative Limit to Date |
|---|---|---|---|---|---|
| Arsenic | | | | | |
| Cadmium | | | | | |
| | | | | | |
| Copper | | | | | |

[4] Attach a sheet showing calculations and all assumptions used for calculating residual nitrogen from previous fertilizer and biosolids applications.

| Pollutant | Total Loadings from Previous Years (kg/ha) | Loading This Year (kg/ha) | Background Soils Conc. (kg/ha) (6" depth) | Cumulative Metal Load to Date (kg/ha) | Percent Cumulative Limit to Date |
|---|---|---|---|---|---|
| Lead | | | | | |
| Mercury | | | | | |
| Molybdenum | | | | | |
| Nickel | | | | | |
| Selenium | | | | | |
| Zinc | | | | | |

4. **Constituent Concentrations (Each Source)**

| Constituent<br><br>Arsenic | Concentration in Biosolids, (mg/kg, dry weight) |
|---|---|
| Cadmium | |
| Chromium | |
| Copper | |
| Lead | |
| Mercury | |
| Molybdenum | |
| Nickel | |
| Selenium | |
| Zinc | |
| Total Solids Content | % |
| Total Nitrogen | |
| Fecal Coliform | MPN/gram |
| Ammonia Nitrogen, as N | |
| Total Phosphorus, as P<br>Total Potassium | |
| SW 846[5] Method 8080 for PCB Aroclors, Aldrin/Dieldrin | |
| EPA Method 8270 Semi-Volatile Organics | |

[5] The discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

5. **Site Map**

Provide a site map identifying the area(s) of application clearly showing each field to which biosolids have been applied and crop planted.

6. **40 CFR Part 503**

Attach a copy of the generator's monitoring report for compliance with the 40 CFR Part 503.

## GENERAL REPORTING

1. Pre-Application Reports shall be submitted for RWQCB staff review and approval at least 30 days prior to application of biosolids. Annual Reports covering the period between January 1 to December 31 shall be submitted by February 15 of the following year. If no applications occurred during the year, the discharger shall submit a report indicating that no discharge occurred during the year.

2. The collection, preservation, and holding times of all samples shall be in accordance with U.S. Environmental Protection Agency approved procedures. All analyses shall be conducted by a laboratory certified by the California Department of Health Services to perform the required analyses. The RWQCB Executive Officer may allow use of an uncertified laboratory in accordance with Provision No. 16.

3. If there is no discharge during a required reporting period, the discharger shall submit a letter report to the RWQCB indicating that there has been no activity during the required reporting period.

4. Each report shall be signed and contain the following certification:

   "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this documentand all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment"

5. A duly authorized representative of the discharger may sign the documents if:

   a. The authorization is made in writing by the person described above;

   b. The authorization specified an individual or person having responsibility for the overall operation of the regulated disposal system; and

   c. The written authorization is submitted to the RWQCB Executive Officer.

6. The discharger shall arrange the data in tabular form so that the specified information is readily discernible. The data shall be summarized in such a manner as to clearly illustrate whether the facility is operating in compliance with waste discharge requirements.

7. Report immediately (within 24 hours) to the RWQCB Executive Officer and Director of County Environmental Health by telephone with a follow-up letter any discharge which threatens the environment or human health. During non-business hours, report to the Office of Emergency Services by telephone at 1-800-852-7550.

8. The results of any monitoring done more frequently than required at the locations specified in the Monitoring and Reporting Program shall be reported to the RWQCB.

**CERTIFICATION**

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on _____.

AYE:

NO:

ABSENT:

ABSTAIN:

_____
Maureen Marché
Administrative Assistant to the Board

# Appendix B. Notice of Preparation and Distribution List

# Notice of Completion

**Form A**

*Mail to:* State Clearinghouse, 1400 Tenth Street, Sacramento, CA 95814 916/445-0613

*See NOTE below*

**SCH #** _____

**Project Title:** NOP for a statewide program EIR on General Waste Discharge Requirements for Biosolids Land Application

Lead Agency: California State Water Resources Control Board — Contact Person: Todd Thompson

Street Address: 901 P Street — Phone: 916/657-0577

City: Sacramento, CA — Zip: 95814 — County: Sacramento

## Project Location

County: entire state — City/Nearest Community: varies

Cross Streets: N/A — Total Acres: N/A

Assessor's Parcel No. N/A — Section: ____ Twp. ____ Range: ____ Base: ____

Within 2 Miles: State Hwy #: ____ Waterways: ____

Airports: ____ Railways: ____ Schools: ____

## Document Type

**CEQA:**
- [x] NOP
- [ ] Early Cons
- [ ] Neg Dec
- [ ] Draft EIR
- [ ] Supplement/Subsequent
- [ ] EIR (Prior SCH No.) ____
- [ ] Other ____

**NEPA:**
- [ ] NOI
- [ ] EA
- [ ] Draft EIS
- [ ] FONSI

**Other:**
- [ ] Joint Document
- [ ] Final Document
- [ ] Other ____

## Local Action Type

- [ ] General Plan Update
- [ ] General Plan Amendment
- [ ] General Plan Element
- [ ] Community Plan
- [ ] Specific Plan
- [ ] Master Plan
- [ ] Planned Unit Development
- [ ] Site Plan
- [ ] Rezone
- [ ] Prezone
- [ ] Use Permit
- [ ] Land Division (Subdivision, Parcel Map, Tract Map, etc.)
- [ ] Annexation
- [ ] Redevelopment
- [ ] Coastal Permit
- [ ] Other ____

## Development Type

- [ ] Residential: *Units* ____ *Acres* ____
- [ ] Office: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Commercial: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Industrial: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Educational ____
- [ ] Recreational ____
- [ ] Water Facilities: *Type* ____ *MGD* ____
- [ ] Transportation: *Type* ____
- [ ] Mining: *Mineral* ____
- [ ] Power: *Type* ____ *Watts* ____
- [ ] Waste Treatment: *Type* ____
- [ ] Hazardous Waste: *Type* ____
- [x] Other: General Waste Discharge Requirements

## Project Issues Discussed in Document

- [x] Aesthetic/Visual
- [x] Agricultural Land
- [x] Air Quality
- [x] Archeological/Historical
- [ ] Coastal Zone
- [x] Drainage/Absorption
- [ ] Economic/Jobs
- [ ] Fiscal
- [x] Flood Plain/Flooding
- [ ] Forest Land/Fire Hazard
- [x] Geologic/Seismic
- [ ] Minerals
- [x] Noise
- [ ] Population/Housing Balance
- [ ] Public Services/Facilities
- [ ] Recreation/Parks
- [ ] Schools/Universities
- [ ] Septic Systems
- [ ] Sewer Capacity
- [x] Soil Erosion/Compaction/Grading
- [x] Solid Waste
- [x] Toxic/Hazardous
- [x] Traffic/Circulation
- [x] Vegetation
- [x] Water Quality
- [x] Water Supply/Groundwater
- [x] Wetland/Riparian
- [x] Wildlife
- [ ] Growth Inducing
- [x] Land Use
- [x] Cumulative Effects
- [x] Other public health

## Present Land Use/Zoning/General Plan Use

N/A

## Project Description

The California State Water Resources Control Board (SWRCB) proposes to adopt a General Order for General Waste Discharge Requirements for the discharge of biosolids to land for use in agriculture, silviculture, horticulture, and land reclamation activities in California. Biosolids are defined as sewage sludge that has been treated tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under federal regulation.

*NOTE:* Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. from a Notice of Preparation or previous draft document) please fill it in.

*Revised October 1989*

# Reviewing Agencies Checklist

**Key**
**S** = Document sent by lead agency
**X** = Document sent by SCH
✓ = Suggested distribution

____ **Resources Agency**
____ Boating & Waterways
✓ Coastal Commission
____ Coastal Conservancy
____ Colorado River Board
____ Conservation
S Fish & Game
✓ Forestry
✓ Office of Historic Preservation
✓ Parks & Recreation
____ Reclamation
✓ S.F. Bay Conservation & Development Commission
S Water Resources (DWR)

**Business, Transportation & Housing**
____ Aeronautics
____ California Highway Patrol
✓ CALTRANS District # ____
____ Department of Transportation Planning
____ Housing & Community Development
S **Food & Agriculture**

**Health & Welfare**
S Health

**State & Consumer Services**
____ General Services
____ OLA (Schools)

**Environmental Affairs**
S Air Resources Board
✓ APCD/AQMD
S California Waste Management Board
____ SWRCB: Clean Water Grants
____ SWRCB: Delta Unit
____ SWRCB: Water Quality
____ SWRCB: Water Rights
S Regional WQCB # ____ (all regions)

**Youth & Adult Corrections**
____ Corrections

**Independent Commissions & Offices**
✓ Energy Commission
✓ Native American Heritage Commission
____ Public Utilities Commission
____ Santa Monica Mountains Conservancy
✓ State Lands Commission
____ Tahoe Regional Planning Agency

____ Other ____

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**Public Review Period** (to be filled in by lead agency)

Starting Date October 26, 1998 Ending Date December 1, 1998

Signature Maggie Townsley Date 10/26/98

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**Lead Agency** (Complete if applicable)

Consulting Firm: Jones & Stokes Associates, Inc.
Address: 2600 V Street
City/State/Zip: Sacramento, CA 95818
Contact: Mike Rushton/Maggie Townsley
Phone: (916) 737-3000

**Applicant:** N/A
Address: ____
City/State/Zip: ____
Phone: (____) ____

**For SCH Use Only:**
Date Received at SCH ____
Date Review Starts ____
Date to Agencies ____
Date to SCH ____
**Clearance Date** ____
Notes:

*Revised October 1989*

# State Water Resources Control Board

**John P. Caffrey, Chairman**

**Peter M. Rooney**
*Secretary for Environmental Protection*

**Division of Water Quality**
901 P Street • Sacramento, California 95814 • (916) 657-0756 FAX (916) 657-2388
Mailing Address: P.O. Box 944213 • Sacramento, California • 94244-2130
Internet Address: http://www.swrcb.ca.gov

**Pete Wilson**
*Governor*


OCT 2 6 1998

To: Interested Agencies and Individuals

NOTICE OF PREPARATION OF A STATEWIDE PROGRAM ENVIRONMENTAL IMPACT REPORT FOR GENERAL WASTE DISCHARGE REQUIREMENTS FOR BIOSOLIDS LAND APPLICATION

The State Water Resources Control Board (SWRCB) will be the lead agency for preparation of a statewide program EIR for the subject project as described in this Notice of Preparation (NOP). One of the principal goals of this NOP is to inform the public about issues related to the project and request information on additional issues that should be addressed in the Environmental Impact Report (EIR). The NOP also seeks public and agency input on the scope and content of the program EIR. The preliminary project description, description of alternatives, and preliminary list of environmental issues to be addressed in the draft EIR are contained in the enclosed materials. This NOP may also be viewed and downloaded in the SWRCB's home page at **http:\\www.swrcb.ca.gov.** We encourage recipients of this notice to inform others who may have an interest or responsibility regarding biosolids land application that this NOP is available for review.

The SWRCB staff has made a preliminary determination that the following issues are of concern and should be addressed in the program EIR:

- hydrology and water quality,
- agriculture and soils,
- public health,
- land use and aesthetics,
- biological resources,
- traffic,
- air quality,
- noise, and
- cultural resources.

# Appendix B. Notice of Preparation

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements (WDRs) for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California. Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under federal regulation. The proposed GO program has several objectives:

- to comply with state-mandated legislation calling for the development of a regulation for land application of biosolids;
- to provide for regional permitting of land application projects through a process that protects water quality; and
- to provide a flexible regulatory framework with regional oversight and incorporation of sound science in the land application of biosolids.

This notice of preparation (NOP), which is required by the California Environmental Quality Act (CEQA), is the first effort to involve the public and interested agencies in developing the scope of the environmental impact report (EIR) for the GO. Section 15083 of the State CEQA Guidelines authorizes and encourages an early consultation or a scoping process to help identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in an EIR and to help resolve concerns of affected agencies and individuals. The intent of the scoping process is to identify the significant issues for study in the EIR and to determine the scope of analysis for each issue. This NOP describes the proposed project and its alternatives, indicates the types of environmental effects that could result from implementation of the program, and announces the start of the EIR review process under CEQA. This NOP contains the following information:

- the purpose of the program EIR, including its intended uses;
- background on and existing regulations for land application of biosolids in California;
- the GO and alternatives to be evaluated in the program EIR; and
- the scope of issues to be addressed in the EIR.

# Project Location

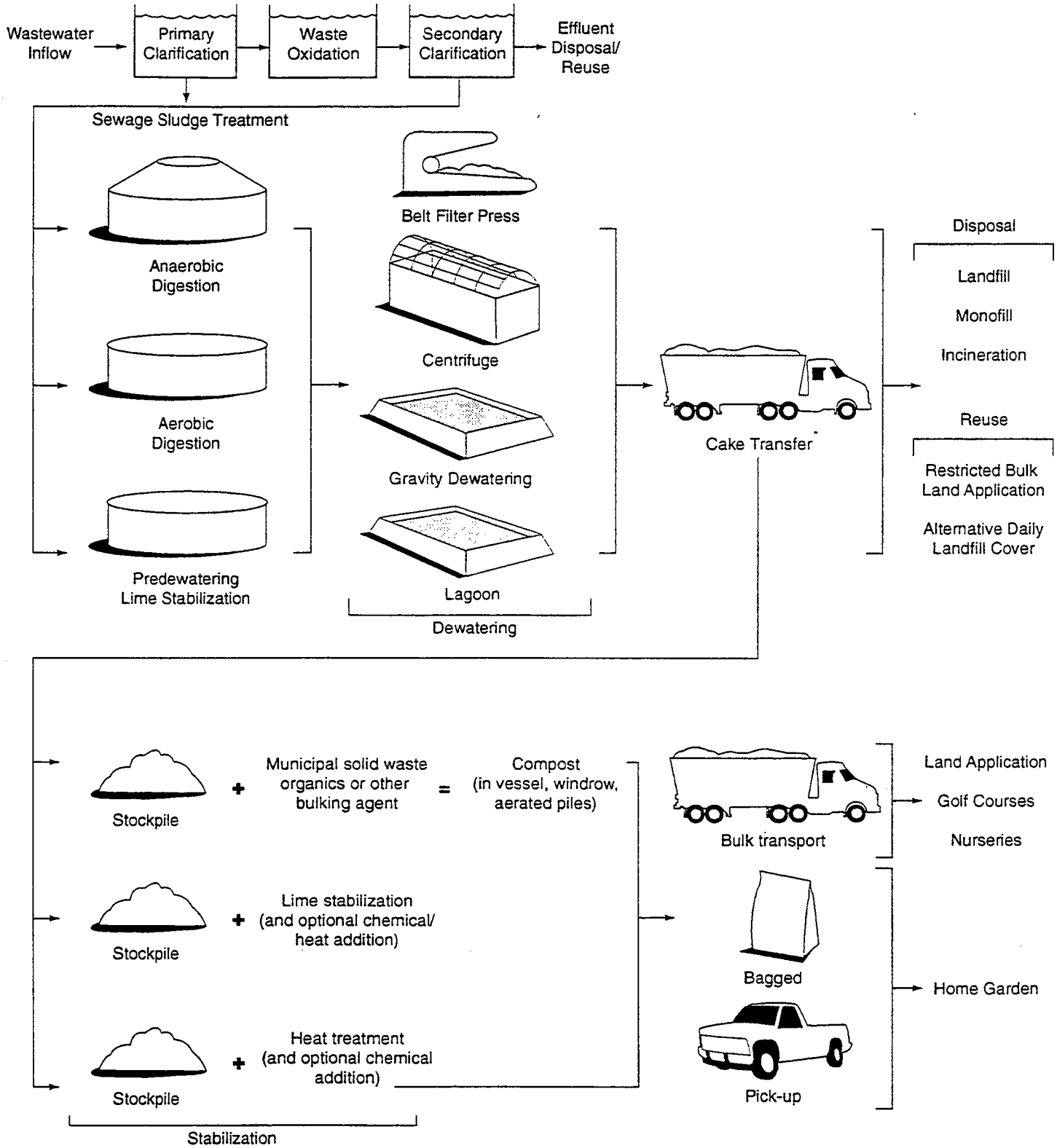
The proposed GO is a regulatory program under the direct purview of the SWRCB, with responsibility for implementation, compliance, and enforcement delegated to each of the nine regional water quality control boards (RWQCBs) in the state. Consequently, biosolids management activities throughout the entire state of California may be affected by this GO. However, specifically identified regions within the state have special environmental significance or are otherwise regulated, and this GO would not apply to those regions. These identified exclusion zones are described in detail under "Project Description".

# Background on Biosolids Management in California

Treatment of municipal wastewater typically generates two waste streams: The liquid component, commonly referred to as effluent, is usually discharged to surface waters or used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB will apply to biosolids as defined in the first paragraph of this notice. Figure 1 shows the processes used to treat sewage sludge to produce biosolids at publicly owned treatment works.

More than 20% of the biosolids generated at wastewater treatment plants in the United States are reused through some form of land application. Land application differs from disposal in that biosolids are applied as an amendment to satisfy or supplement the nutrient requirements of crops or vegetation or to condition soils. Land application may involve the use of biosolids on traditional agricultural crops, silvicultural operations, or horticultural plants or in reclamation of disturbed lands or the application of composted or thermally processed materials to public use areas such as parks and residential landscaping. Certain precautions must be taken to ensure that land application does not endanger public health or adversely affect the environment. The U.S. Environmental Protection Agency (EPA) considers land application a beneficial use because it recycles the nutrients and organic matter contained in biosolids back to the soil (U.S. Environmental Protection Agency 1994). Figure 2 shows typical land application practices for agricultural crop production, including staging (or temporary stockpiling of biosolids) at the farm, loading and spreading of biosolids, and incorporation practices.

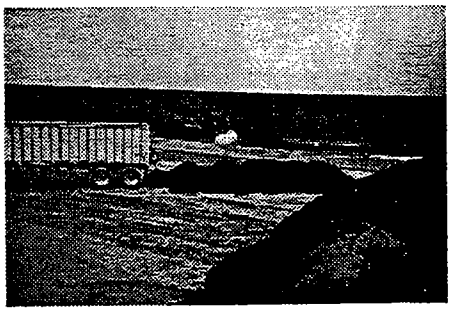
Land application of biosolids is currently regulated by EPA under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), adopted in 1993. The Part 503 regulations were



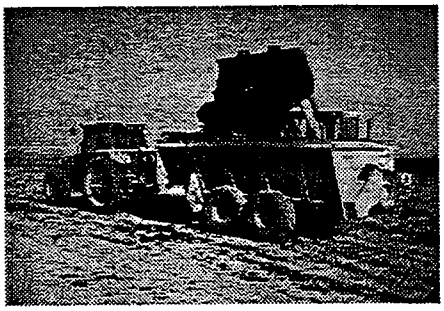

SOURCE:
Modified from Carollo Engineers 1997.

Jones & Stokes Associates, Inc.

**Figure 1**
**Typical Biosolids Management Practices**

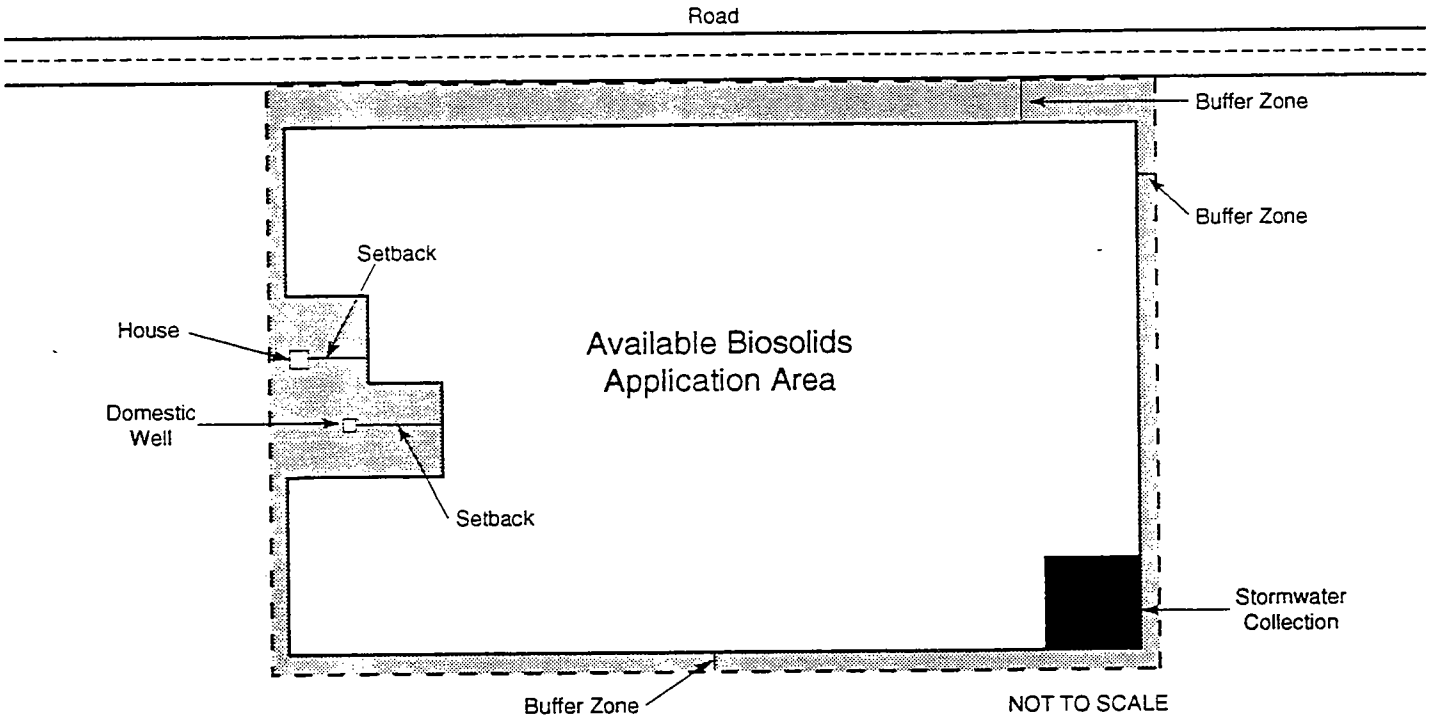


Biosolids staging at farm

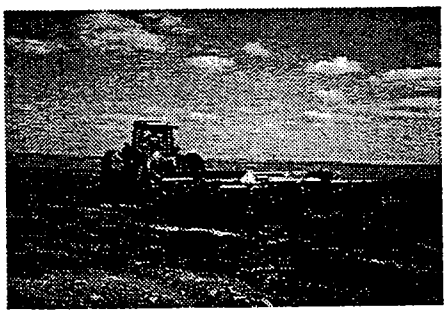


Loading spreader

Land application by spreader



Land application by injection



Incorporation of biosolids into soil

SOURCE:
Carollo Engineers 1997. Photographs provided by the Merriwood Corporation and QUAD Consultants.

Jones & Stokes Associates, Inc.

**Figure 2**
**Typical Biosolids Land Application Site**

developed using a risk-based approach to determine appropriate treatment, storage, and application procedures for biosolids that would protect human health and the environment from potentially dangerous or toxic constituents that may be present in biosolids. The Part 503 regulations control the final use of biosolids according to various constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. The regulations were developed through extensive scientific peer review, and public notification and comment were sought before they were adopted. Many state and local agencies now rely on the Part 503 regulations for guidance when making decisions about biosolids management or establishing biosolids use regulations.

No single state agency regulates biosolids management in California; biosolids recycling projects may involve oversight by the nine RWQCBs, the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA) (California Water Environment Association 1998). In 1983, the California Department of Health Services (DHS) published the Manual of Good Practice for Landspreading Sewage Sludge to promote recycling efforts (California Department of Health Services 1983). Land application of biosolids in California is currently permitted through individual WDRs issued by the RWQCBs in accordance with Title 23, Chapter 9, Division 3 of the California Code of Regulations. Some counties have made land application of biosolids exempt from solid waste regulations, and others have taken an active role in dictating where and how biosolids can be disposed of in their jurisdictions. Some counties have banned the use of biosolids for land application.

To streamline the biosolids permitting process, the Central Valley and Lahontan RWQCBs developed separate general WDRs (another name for GOs) for biosolids land application in 1995. To comply with CEQA, the two RWQCBs prepared negative declarations before adopting their programs. Biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. Petitions were subsequently filed with the SWRCB contesting those WDRs. The decisions regarding both petitions were resolved in favor of the petitioner, and the SWRCB sent the GOs back to the respective RWQCBs for revision. However, in rescinding the Central Valley RWQCB's GO, the SWRCB allowed for the continued land application of biosolids on GO sites where the owners had filed for permit coverage before April 1, 1996. In May 1996, while the SWRCB was considering the petitions, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking to rescind the SWRCB's interim permission for biosolids land application under the GO unless an EIR was prepared subsequently. On June 12, 1997, the Superior Court decided that the SWRCB had exceeded its authority in allowing a limited number of projects to proceed. On September 12, 1997, that decision was amended when Judge Ford of the Superior Court ruled to allow the continued application of biosolids on subject sites and ordered the SWRCB to develop a statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The

program EIR that is the subject of this NOP is being prepared to comply with that court order.

# Project Description

## Applicability of the GO Program

The GO program will establish a notification and permit review process for all persons and public entities intending to apply biosolids in bulk for large-scale agricultural, silvicultural, or horticultural uses on sites subject to the jurisdiction of the RWQCBs. The GO is based on the Part 503 regulations and defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers must adhere. EPA developed the Part 503 regulations to protect highly exposed persons from both pathogens and pollutants. In addition, biosolids regulated under this program must not contain pollutants in concentrations that would exceed the regulatory thresholds for classification as hazardous waste.

Under the GO, the discharger (defined as the individual, business, or organization involved in transporting and applying biosolids) would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO. The GO applies to the discharger and the owner of site where the biosolids are applied; it is not intended to regulate the generator of biosolids. A key component of the GO requires each biosolids application project operator to prepare and submit a notice of intent (NOI) and filing fee to the appropriate RWQCB (the board for the area in which the biosolids are to be applied) before the application of any biosolids. The RWQCB reviews information contained in the NOI and, if it is found to be adequate, issues a notice of applicability under the general WDRs of the GO. A complete NOI includes a preapplication report that provides the RWQCB with specific information about each field or distinct application area:

- contact personnel;
- project location;
- a map that shows site topography; the locations of staging, storage, and application areas; and surface waters and groundwater wells;
- the source of and chemical test results for the subject biosolids;

- a description of proposed application practices and type of crops to be grown;
- a spill response plan; and
- any applicable erosion control, biosolids storage, and groundwater monitoring plans that would be required under the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project under the jurisdiction of the GO must file a separate NOI and filing fee, regardless of the size of the application site. A permitted project may involve either a single application of biosolids or repeated applications. The permitted activities under the GO do not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse. The discharger is responsible for obtaining applicable local permits and authorizations.

## Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program.

- Biosolids must be treated to reduce potential disease-causing pathogens.
- Class A biosolids have been treated to eliminate essentially all pathogens; Class A biosolids must be monitored for bacteria growth at the time of use.
- Class B biosolids have been treated to significantly reduce, but not completely eliminate, pathogens. Land application of biosolids that meets Class B criteria is restricted by the following conditions:
  - food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;
  - food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;
  - food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;

- feed and fiber crops cannot be harvested for 30 days after biosolids application;
- animals cannot be grazed on the site within 30 days of biosolids application;
- turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);
- public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application; and
- public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes or management practices that the biosolids must undergo to reduce vector attraction. Vectors are pests (e.g., flies, mosquitos, and rodents) that can be attracted to incompletely treated biosolids and could transmit diseases to other organisms. Biosolids must be treated to at least Class B pathogen reduction and vector-attraction reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of nine trace metals regulated under the Part 503 regulations (Table 1). Biosolids are considered Exceptional Quality (EQ) if they meet all of the pollutant concentration limits and the Class A pathogen reduction standards. EQ biosolids can be distributed in bulk or packaged in bags and are not subject to general management practices other than monitoring and reporting to confirm that the criteria have been met. Biosolids that contain any one of the nine pollutants in concentrations that exceed the EQ pollutant concentration limits, but are below the ceiling limits, can be applied to land but are subject to cumulative and annual pollutant loading restrictions depending on their intended use (Table 1). Biosolids with all pollutants below the concentration limits for EQ biosolids can be applied without loading rate restrictions. If the biosolids contain any of the listed pollutants at concentrations that exceed the ceiling concentration limits, they cannot be applied to land.

## Discharge Prohibitions under the GO

Specific discharge prohibitions apply to all land application projects that request authorization under the GO. In general, biosolids application must meet the following conditions:

- the biosolids cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;
- no application is permitted until the RWQCB has issued a notice of applicability, a set of individual WDRs, or a waiver of WDRs;
- no application is permitted where the application rate would exceed the agronomic rate of nitrogen uptake by plants unless specifically authorized (application may no application is permitted where the discharge would cause or threaten to cause pollution or create a nuisance as defined in Section 13050 of the California Water Code;
- no application is permitted in areas not specified in the applicant's NOI;
- no application is permitted to surface waters or drainage courses;

### Table 1. Regulatory Pollutant Concentrations and Loading Rates under Part 503 Regulations

| Pollutant | Pollutant Concentration in EQ Biosolids (mg/kg) | Ceiling Concentration in Biosolids Applied to Land (mg/kg) | Cumulative Pollutant Loading Rate Limits (kg/ha) | Annual Pollutant Loading Rate Limits (kg/ha/yr) |
|---|---|---|---|---|
| Arsenic | 41 | 75 | 41 | 2 |
| Cadmium | 39 | 85 | 39 | 1.9 |
| Copper | 1,500 | 4,300 | 1,500 | 75 |
| Lead | 300 | 840 | 300 | 15 |
| Mercury | 17 | 57 | 17 | 0.85 |
| Molybdenum | -- | 75 | -- | -- |
| Nickel | 420 | 420 | 420 | 21 |
| Selenium | 100 | 100 | 100 | 5 |
| Zinc | 2,800 | 7,500 | 2,800 | 140 |
| Applied to: | Bulk biosolids and bagged biosolids | All biosolids that are land applied | Bulk non-EQ biosolids | Bulk biosolids |

Notes: mg/kg = milligrams per kilogram.
kg/ha = kilograms per hectare.
kg/ha/yr = kilograms per hectare per year.

Sources: Pollutant concentration in EQ biosolids—Part 503, Table 3; ceiling concentration in biosolids applied to land—Part 503, Table 1.

- be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade underlying groundwater);
- the site must not produce runoff within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;
- no application is permitted to frozen or water-saturated ground or during periods of rain;
- no application is permitted when wind may reasonably be thought to cause biosolids to drift from the site; and
- no application is permitted in areas subject to erosional inundation or a washout environment from a 100-year return frequency rain event.

## Discharge Specifications under the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be applied to land. Most of these specifications are similar to the requirements of the Part 503 regulations:

- Biosolids must be treated to meet Part 503 standards for vector-attraction reduction and be treated to either the Class A or Class B level of pathogen reduction standards.
- Cumulative (i.e., lifetime) pollutant loading limits for a given site are specified at the same level as those allowed under Part 503.
- Following incorporation of biosolids into the ground, tilling practices must minimize the potential for erosion of the site from wind, stormwater, and irrigation water.
- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.

For Class B biosolids, the harvesting period for crops is restricted in an identical fashion to the restrictions imposed by the Part 503 regulations. In addition, the location of application is limited with respect to property lines, municipal and agricultural water supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

## Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirements that biosolids be transported in covered, leakproof vehicles and that drivers carry a copy of an approved spill response plan and be trained in its use to ensure proper response to accidents or spill events. The GO defines storage as placement of biosolids on the ground or in nonmobile containers at an intermediate site other than the place of generation or processing for more than 7 days. If biosolids are to be stored at the application sites, the operator must prepare and implement a RWQCB-approved storage program. In general, biosolids must not be stored for more than 7 days, storage areas must be covered between October 1 and April 30, and control measures should be in place to prevent biosolid-related materials from leaching into the soil, entering surface runoff, and being washed out by floods.

## GO Exclusion Areas

The proposed GO specifies several areas and characteristic land areas in which biosolids application projects cannot be permitted under the GO. The exclusion areas are generally protected from exposure to biosolids because they are unique or valuable public resources, jurisdictional waters or preserves, or locally designated management areas. The general areas excluded from this GO include the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta and Suisun Marsh areas;
- the jurisdiction of the San Francisco Bay Conservation and Development Commission; and
- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,200 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and portions of the Mono-Owens Planning Area.

# Project Alternatives

Section 15126(d) of the State CEQA Guidelines provides the following guidance regarding alternatives analysis in an EIR:

> Describe a range of reasonable alternatives to the project, or to the location of the project, 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 proposed project, which is the GO, is a regulatory program that is designed to reduce the potential for adverse environmental effects from land application of biosolids. The program's objectives are to meet the requirements of current state law and a judicial order regarding biosolids regulation; provide regulation through a uniform, statewide, or regional approach that can be efficiently administered on a regional basis by the RWQCBs and effectively minimize adverse environmental effects; and establish a regulation that is flexible and based on sound science and best professional judgment. Given these project objectives and the fact that the program is already designed to minimize adverse effects, the range of alternatives available to further reduce the adverse environmental effects of the project is limited. The alternatives being considered for this EIR are described below.

- **No Project**—The analysis of the No-Project Alternative will consider existing conditions relating to regulation of biosolids application to land, as well as what would be reasonably expected to occur in the foreseeable future if the GO were not approved. Under this scenario, land application of biosolids would likely continue to be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations.

- **Modified GO Provisions and Specifications**—This alternative will be developed during and after the EIR scoping process. It will contain changes to the GO provisions, specifications, or exclusion areas so that adverse environmental effects expected to result from the GO will be eliminated or their severity reduced. Because the significance of potential project impacts is not yet known, the specific changes to the GO cannot be specified until later in the environmental review process.

- **Regulation through RWQCB General Orders**—The objectives of the proposed statewide GO could be met through development and use of GOs by the individual RWQCBs. General orders would be developed by each RWQCB that receives applications for WDRs. These regulations could be similar to or the

same as those contained in the proposed project. Some variation in regulations between the individual RWQCBs would be likely because of differences in local conditions.

## Issues to Be Discussed in the Draft Program EIR

The following lists identify the resource areas and potential environmental effects that will be discussed in the draft program EIR for the proposed GO. **One of the principal goals of this NOP is to inform the public about issues related to the project and request information on additional issues that should be addressed.**

### Hydrology and Water Quality

- Potential effects on the hydrology or beneficial uses of surface water or groundwater supplies where biosolids are applied to land
- Potential for conflicts with adopted RWQCB water quality control plan policies regarding attainment of beneficial uses for surface water and groundwater resources
- Potential long-term water quality impacts from biosolids application under extreme or variable site-specific environmental conditions
- Potential water quality impacts from transportation-related spills of biosolids

### Agriculture and Soils

- Potential long-term effects of the accumulation of trace metals and other biosolids constituents in soils
- Potential for adverse effects on soil productivity, especially in areas of extreme soil conditions such as salt-affected environments
- Potential for adverse effects on soil productivity for specific crops

### Public Health

- Potential human health effects from biosolids application under extreme or variable site-specific conditions

- Potential health effects from biosolids application on land used for growing crops for human consumption
- Potential acute and chronic health effects on humans from exposure to regulated and unregulated constituents of concern and pathogenic organisms
- Potential changes (antagonistic and synergistic) in factors influencing human, plant, and animal diseases

**Land Use and Aesthetics**

- Potential land use compatibility and aesthetic conflicts
- Relation of potential land use impacts to other issues of concern, such as traffic and air quality
- Consistency with local land use policies and procedures

**Biological Resources**

- Potential effects on sensitive biological resources, including special-status species and sensitive plant communities
- Potential for incidental take of a threatened or endangered species
- Potential conflicts with regulatory policies or procedures for protection of biological resources

**Traffic**

- Potential changes in vehicle miles traveled in an area as a result of transport and reuse or disposal of biosolids
- Potential effects of biosolids transport on the roadway system and roadbed structure in the immediate vicinity of the biosolids application sites
- Potential changes in required roadway maintenance or conflicts with local transportation plans

**Air Quality**

- Potential changes in local air quality conditions as a result of land application of biosolids, and the resulting impacts on sensitive receptors
- Potential for localized changes in odors, vehicle emissions, and effects from wind drift
- Potential change in pollutant emissions as a result of biosolids transport

**Noise**

- Potential changes in local noise conditions as a result of land application of biosolids, and the resulting impacts on sensitive receptors
- Potential noise impacts from transport of biosolids based on local thresholds and sensitivities

**Cultural Resources**

- Potential for biosolids application projects to damage, degrade, or otherwise adversely affect significant cultural resources

**Cumulative Impacts**

- Evaluation of the project in conjunction with reasonably foreseeable projects or programs that could result in cumulative resource impacts, especially in areas where water quality, agricultural productivity, air quality, traffic and noise levels, or biological and cultural resources are currently impaired

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# Appendix C. Existing Regulatory Programs for Biosolids Land Application

## Summary of Federal, State and Regulatory Requirements

Numerous federal, state, and local agencies currently regulate biosolids land application. Agency jurisdiction may vary depending on the beneficial use/disposal methods employed and location. In general, the United States Environmental Protection Agency (EPA) provides federal regulations that are implemented by state and local governments. In California, many state and local agencies have developed additional rules, guidelines, and criteria for biosolids regulation.

**Table 1 Federal Regulations Governing Biosolids**

| | Federal Regulation | Land Application | Distribution and Marketing | Monofills and Surface Disposal | Codisposal Landfill and Landfill Cover |
|---|---|---|---|---|---|
| 40 CFR 122-124 | Requires biosolids disposal to be included in NPDES | X | X | X | X |
| 40 CFR 257 | Regulates use and disposal of biosolids not regulated by 40 CFR 503 | X | X | X | X |
| 40 CFR 261-268, 271, and 301 | Defines whether biosolids are hazardous | X | X | X | X |
| 40 CFR 501 | Requires states to implement federal regulations for biosolids | X | X | X | X |
| 40 CFR 503 | Regulates land application, surface disposal, and incineration | X | X | X | X |
| 40 CFR 761 | Defines biosolids containing more than 50 mg/kg of PCBs as toxic | X | X | X | X |

## Federal Requirements

The EPA is the primary federal agency having jurisdiction over biosolids management. It is the responsibility of each state to develop programs to implement the rules and guidelines established by EPA. In general, state compliance with EPA guidelines is verified by EPA's regional offices.

Congress has been aware of biosolids use and disposal problems since passing the Clean Water Act (CWA) in 1972. However, regulations governing biosolids management practices did not appear until 1977, when amendments to the CWA led to the promulgation of 40 CFR Part 257 (under the joint authority of the CWA and the Resource Conservation and Recovery Act [RCRA]). Passage of Part 257 established standards for cadmium, PCBs, and pathogens in biosolids applied to land and established general management standards for solid waste landfills. In addition to the CWA, several other federal laws provide authority to regulating various aspects of

biosolids disposal. These include the Clean Air Act; Subtitles C and D of RCRA; the Marine Protection, Research, and Sanctuaries Act (MPRSA); the Toxic Substances Control Act; and the recently promulgated 40 CFR Part 503 Standards for the Use and Disposal of Sewage Sludge. Table 5.1 lists current federal regulations that directly apply to the land application of biosolids.

**Recent Federal Activity**

In 1987, Congress called upon the EPA to comprehensively regulate the use and disposal of biosolids with the passage of the Water Quality Act of 1987 (P.L. 100-4)(WQA). This act required the promulgation of technical standards and placed new emphasis on identifying and limiting those toxic pollutants in biosolids that may adversely affect public health or the environment. Congress further required that EPA implement the technical standard through NPDES permits issued to POTWs unless current permit conditions issued under other federal programs or state programs ensured compliance with Section 405.

In order to implement the long-term biosolids permitting program required by the WQA, EPA has initiated two rulemakings. The first rulemaking includes 40 CFR Parts 122, 123, and 124 and 40 CFR Part 501. Parts 122, 123, and 124 set requirements and procedures for including biosolids conditions in NPDES permits. Part 501 sets requirements and procedures for approving state biosolids management programs to operate in lieu of federal programs, or for federal programs to implement biosolids permits if a state so chooses. The second rulemaking, 40 CFR Part 503 (503), adopted February 19, 1993 sets the technical standards for biosolids use and disposal.

As stated previously, biosolids land application is regulated at the federal level by the EPA through the 40 CFR Part 503 (503) regulations. These regulations establish standards for pollutant limits, operational standards, management practices, and monitoring, recordkeeping, and reporting requirements. The regulation is self-implementing and imposes requirements on persons who prepare sewage biosolids or material derived from sewage biosolids and land appliers of sewage biosolids. Compliance with the 40 CFR Part 503 standards became effective February 19, 1994. To land apply biosolids, the biosolids must satisfy the requirements for pollutant limitations, pathogen reduction, and vector attraction reduction as described in the following sections.

**Pollutants Limits**

Tables 2 and 3 present standards for the metals regulated by 503 for land application of biosolids. The 503 pollutant concentrations and ceiling concentrations are presented in Table 5.2. Biosolids with pollutant levels greater than the 503.13 Table 1 ceiling concentrations cannot be applied to land. Biosolids with pollutant levels below the 503.13 Table 1 ceiling concentrations, but above pollutant concentrations in 503.13 Table 3 can be applied to land, but are subject to the annual and cumulative pollutant loadings shown in Table 3. Biosolids with pollutant levels below 503.13 Table 3 limits can be applied to land without regard to annual or cumulative loading restrictions.

**Pathogen Reduction**

In addition to pollutant concentrations, biosolids must not pose a public health risk. 40 CFR Part 503, therefore, stipulates that biosolids applied to land must also be treated for pathogen and vector attraction reduction. 503 gives both performance-based standards and technology based standards for methods to reduce pathogens.

The 40 CFR Part 503 identifies two levels of pathogen reduction requirements, Class A and Class B, which may be satisfied by certain treatment methods and/or by meeting pathogen limitation standards. The goal of Class A requirements is to reduce pathogens to below

detectable limits. The goal of Class B biosolids is to meet adequate pathogen reduction requirements and to rely upon

| Table 2 CFR Part 503 Land Application - Pollutant Concentration Limits | | |
|---|---|---|
| Pollutant | 503.13 Table 1 Ceiling Concentrations (mg/kg)(1) | 503.13 Table 3 Pollutant Concentrations (mg/kg)(1) |
| Arsenic | 75 | 41 |
| Cadmium | 85 | 39 |
| Copper | 4,300 | 1,500 |
| Lead | 840 | 300 |
| Mercury | 57 | 17 |
| Molybdenum | 75 | NA(2) |
| Nickel | 420 | 420 |
| Selenium | 100 | 100 |
| Zinc | 7,500 | 2,800 |

Notes:
(1) Dry weight basis.
(2) Temporarily suspended by EPA pending further consideration. Value was 18 mg/kg.

environmental factors at the beneficial site to further reduce pathogens. Therefore, sites which use Class B biosolids must follow additional site restrictions concerning public access, animal grazing, and crop harvesting.
The 40 CFR Part 503 provides various alternatives for meeting Class A and Class B pathogen requirements. Class A biosolids must meet the following two criteria:

1. One of the Class A pathogen reduction alternatives listed on Table 4 must be met before or at the same time as vector attraction, except when vector attraction reduction is met by Options 6, 7, or 8 (see Table 5.12), and

| Table 3 40 CFR Part 503 Annual and Cumulative Land Application Rates | | |
|---|---|---|
| Pollutant | 503.13 Table 2 Cumulative Pollutant Loading Rate (kg/hectare) | 503.13 Table 4 Annual Pollutant Loading Rate (kg/hectare/year) |
| Arsenic | 41 | 2.0 |
| Cadmium | 39 | 1.9 |
| Copper | 1,500 | 75 |
| Lead | 300 | 15 |
| Mercury | 17 | 0.85 |
| Molybdenum | NA(1) | NA(2) |
| Nickel | 420 | 21 |
| Selenium | 100 | 5.0 |
| Zinc | 2,800 | 140 |

Notes:
(1) Temporarily suspended by EPA pending further review. Value was 18 kg/hectare.
(2) Temporarily suspended by EPA pending further review. Value was 0.90 kg/hectare/yr.

| Table 4 40 CFR Part 503 Class A Pathogen Reduction Alternatives | |
|---|---|
| **Alternative** | **Description** |
| A1: Thermally Treated Biosolids | Maintain biosolids at certain elevated temperature for prescribed period of time (see 503 Regulations for details). |
| A2: Biosolids Treated in a High pH-High Temperature Process | Maintain biosolids at certain elevated temperature and pH for prescribed period of time (see 503 Regulations for details). |
| A3: Biosolids Treated in Other Process | • The density of enteric viruses in the biosolids after pathogen treatment must be less than 1 PFU per 4 grams of total solids.<br>• The density of viable helminth ova in the biosolids after pathogen treatment must be less than 1 per 4 grams of total solids.<br>• Report operating parameters to indicate consistent pathogen reduction treatment. |
| A4: Biosolids Treated in Unknown Processes | • The density of enteric viruses in the biosolids after pathogen treatment must be less than 1 PFU per 4 grams of total solids.<br>• The density of viable helminth ova in the biosolids after pathogen treatment must be less than 1 per 4 grams of total solids. |
| A5: Processes to Further Reduce Pathogens (PFRP) | |
| Composting | Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the biosolids is maintained at 55 degrees Celsius or higher for three days.<br><br>Using the windrow composting method, the temperature of the biosolids is maintained at 55 degrees or higher for 15 days or longer. During the period when the compost is maintained at 55 degrees or higher, there shall be a minimum of five turnings of the windrow. |
| Heat Drying | Biosolids is dried by direct or indirect contact with hot gases to reduce the moisture content of the biosolids to 10 percent or lower. Either the temperature of the biosolids particles exceeds 80 degrees Celsius or the wet bulk temperature of the gas in contact with the biosolids as the biosolids leaves the dryer exceed 80 degrees Celsius. |
| Heat Treatment | Liquid biosolids is heated to a temperature of 180 degrees Celsius or higher for 30 minutes. |
| Thermophilic Aerobic Digestion | Liquid biosolids is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time of the biosolids is 10 days at 55 to 60 degrees Celsius. |
| Beta Ray Irradiation | Biosolids is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius). |
| Gamma Ray Irradiation | Biosolids is irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20 degrees Celsius). |
| Pasteurization | The temperature of the biosolids is maintained at 70 degrees Celsius or higher for 30 minutes or longer. |
| A6: Use of Processes Equivalent to PFRP | Demonstrate operating parameters and/or pathogen levels to be PFRP equivalent subject to permitting authority approval. |

2. Class A biosolids must be monitored for bacteria regrowth at the time of usage or disposal. Fecal coliform density must be less than 1,000 Most Probable Number (MPN) per gram of total dry solids (1,000 MPN/g TS) or Salmonella sp. density less than 3 MPN per 4 grams of total dry solids (3 MPN/4g TS).

Biosolids that are to be land applied must, at a minimum, meet Class B pathogen reduction re quirements and provide for site restrictions. Alternatives for Class B are shown on Table 5.

**Table 5 40 CFR Part 503 Class B Pathogen Reduction Alternatives**

| Alternative | | Description |
|---|---|---|
| B1: | Monitoring of Fecal Coliform | The geometric mean of seven samples of treated biosolids, collected at time of use or disposal shall meet a fecal coliform density of less than 2 million colony forming units or most probable number per gram of biosolids solids (dry weight basis). |
| B2: | Processes to Significantly Reduce Pathogens (PSRP) | |
| | Aerobic Digestion | Biosolids is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius. |
| | Air Drying | Biosolids is dried on sand beds or on paved or unpaved basins. The biosolids dries for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius. |
| | Anaerobic Digestion | Biosolids is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35 to 55 degrees Celsius and 60 days at 20 degrees Celsius. |
| | Composting | Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the biosolids is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius. |
| | Lime Stabilization | Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after two hours of contact. |
| B3: | Use of Processes Equivalent to PSRP | Demonstrate operating parameters and/or pathogen levels to be PSRP equivalent subject to permitting authority approval. |

**Site Restrictions**

Biosolids meeting Class B pathogen reduction requirements must also comply with the following site restrictions.

1. Food crops with harvested parts that touch the biosolids/soil mixture (such as melons, cucumbers, squash, etc.) shall not be harvested for 14 months after application of biosolids.
2. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 20 months after application of biosolids if the biosolids had been stored on land surface for at least 4 months prior to incorporation into the soil.
3. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 38 months after application if the biosolids had been stored on land surface for less than 4 months prior to incorporation into the soil.
4. Food crops, feed crops, and fiber crops shall not be harvested for 30 days after biosolids application.
5. Animals shall not graze on a site for 30 days after biosolids application.
6. Turf shall not be harvested for one year after biosolids application if the turf is placed on land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.
7. Public access to land with high potential for public exposure shall be restricted for 1 year after biosolids application.
8. Public access to land with a low potential for public exposure shall be restricted for 30 days after biosolids application.

**Vector Attraction Reduction**

Vector attraction is any characteristic which attracts disease vectors. Disease vectors are insects or animals which are capable of transporting and transmitting infectious agents. Some common vectors include flies, mosquitos, and rodents. Their interaction with humans provides a pathway for transmission of disease. Vectors themselves are not pathogenic. The 40 CFR Part 503 specifies ten alternatives for meeting the vector attraction reduction requirement as shown on Table 6.

**Exceptional Quality Biosolids**

Biosolids that meet the High Quality Pollutant Concentrations listed in Table 5.8, one of the Class A pathogen reduction requirements, and one of the vector attraction reduction alternatives (Options 1 through 8) may be identified as "exceptional quality biosolids." Exceptional quality biosolids may be used and distributed in bulk or bag form and are not subject to general requirements and management practices other than monitoring, recordkeeping, and reporting to substantiate that the quality criteria have been met.

**Table 6 40 CFR Part 503 Vector Attraction Reduction Requirements**

| Option | Process |
|---|---|
| (1) | The mass of volatile solids in the biosolids shall be reduced by a minimum of 38 percent during biosolids treatment. |

| Table 6 | 40 CFR Part 503 Vector Attraction Reduction Requirements |
|---|---|
| **Option** | **Process** |
| (2) | When the 38 percent volatile solids reduction requirement cannot be met for an anaerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When, at the end of the 40 days, the volatile solids in the biosolids at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved. |
| (3) | When the 38 percent volatile solids reduction requirement in cannot be met for an anaerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for 30 additional days at 20 degrees Celsius. When, at the end of the 30 days, the volatile solids in the biosolids at the beginning of that period is reduced by less than 15 percent, vector attraction reduction is achieved. |
| (4) | The specific oxygen uptake rate (SOUR) for biosolids treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius. |
| (5) | Biosolids shall be treated in an aerobic process for 14 days or longer. During that time, the temperature of the biosolids shall be higher than 40 degrees Celsius and the average temperature of the biosolids shall be higher than 45 degrees Celsius. |
| (6) | The pH of biosolids shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours at 25 degrees Celsius. |
| (7) | The percent solids of biosolids that does not contain unstabilized solids shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials. |
| (8) | The percent solids of biosolids that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials. |
| (9) | Biosolids shall be injected below the surface of the land. No significant amount of the biosolids shall be present on the land surface within one hour after the biosolids is injected. When the biosolids that is injected below the surface of the land is Class A with respect to pathogens, the biosolids shall be injected below the land surface within eight hours after being discharged from the pathogen reduction process. |
| (10) | Biosolids applied to the land surface or placed on a surface disposal site shall be incorporated into the soil within six hours after application to or placement on the land. When biosolids that is incorporated into the soil is Class A with respect to pathogens, the biosolids shall be applied to or placed on the land within eight hours after being discharged from the pathogen treatment process. |
| (11) | Biosolids placed on a surface disposal site shall be covered with soil or other material at the end of each operating day. |
| (12) | The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes at 25 degrees Celsius. |

## Management Practices

The following are a few general management practice guidelines for the land application of biosolids.

1. Bulk biosolids shall not be applied to the land if it is likely to adversely affect a threatened or endangered species listed under Section 4 of the Endangered Species Act or its designated critical habitat.

2. Bulk biosolids shall not be applied to agricultural land, forest, a public contact site, or a reclamation site that is flooded, frozen, or snow-covered so that the bulk biosolids enters a wetland or other waters of the United States, as defined in 40 CFR Part 122.2, except as provided in a permit issues pursuant to Section 402 or 404 of the Clean Water Act.

3. Bulk biosolids shall not be applied to agricultural land, forest, or a reclamation site that is 10 meters (33 feet) or less from waters of the United States, as defined in 40 CFR 122.2, unless otherwise specified by the permitting authority.

**Distribution and Marketing of Biosolids Products**

The distribution and marketing of biosolids-derived fertilizers and soil conditioners are regulated under 40 CFR Part 503. Biosolids applied to farmland, forest, and reclamation sites must at a minimum meet the pollutant Ceiling Concentration Limits from Table 2, Class B pathogen requirements, and vector attraction reduction requirements. The biosolids can be applied using the Cumulative Pollutant Loading Rates under Table 3 if the biosolids do not meet the pollutant Ceiling Concentrations. Biosolids that are applied on lawns and home gardens must meet Class A pathogen requirements, a vector attraction reduction requirement, and the High Quality Pollutant Concentration listed in Table 2. The exception is that biosolids which meet the pollutant Ceiling Concentration, but not the High Quality Pollutant Concentration can be sold for use at product application rates prescribed on a label that are based on meeting Annual Pollutant Loading Rates.

Overall, a label shall be affixed to the bag or other container in which biosolids are sold or given away for application to land, or an information sheet shall be provided to the person who receives biosolids sold or given away in a container for application to the land. The label or information sheet shall contain the following information:

1. The name and address of the person who prepared the biosolids that is sold or given away in a bag or other container for application to the land;

2. A statement that application of the biosolids to the land is prohibited except in accordance with the instructions on the label or information sheet; and

3. The annual whole sludge application rate for the biosolids that does not cause any of the annual pollutant loading rates in Table 3 to be exceeded.

**Monitoring Frequency**

Monitoring frequency for pollutants, pathogen densities, and vector attraction reductions is based on the amount of biosolids used or disposed as shown on Table 7. More frequent monitoring is encourage to check quality abnormalities. Alternatives which use operating parameters to satisfy pathogen and vector attraction reduction requirements should monitor operations continuously.

**Table 7 40 CFR Part 503 Monitoring Frequency**

| Amount of Biosolids Used or Disposed (metric tons per 365 day period - dry weight)[1] | Monitoring Frequency per Year |
|---|---|
| 0 > amount > 290 | Once |
| 290 ≥ amount > 1,500 | Quarterly (4 times) |
| 1,500 ≥ amount > 15,000 | Bimonthly (6 times) |
| amount ≥ 15,000 | Monthly (12 times) |

(1) 1 metric ton = 1.1 English tons.

**Recordkeeping**

Generally, the preparer(s) of the biosolids is required to maintain records of the biosolids to meet pollutants, pathogens, and vector attraction reduction requirements. The applier(s) are required to maintain records of application rates, management practices, and site restrictions. Records must be kept for five years.

**Reporting**

Annual reports are due to the permitting authority February 19 every year from all POTWs with a design flow of 1 million gallons per day (mgd) or greater or which service a population of 10,000 people or greater.

These 503 standards, which are known as the Round 1 regulations, set limits for nine heavy metals in biosolids that are land applied. Meanwhile, the EPA continued to evaluate 31 candidate pollutants for Round 2 of the regulation. Based on the results of risk assessment screening, EPA concluded that 2 of the 31 pollutants warrant further consideration for regulations:

1. Dioxins/dibenzofurans.
2. Polychorinated biphenyls (co-planes) (PCB).

Currently, the EPA has not established any preliminary range of concentration limits for these constituents. Per discussions with Lauren Fondahl of EPA Region IX, possible limits may be derived from other current regulations. The dioxin limitation may reference the pulp and paper mill discharge limitation which ranges from an average concentration of 10 parts per trillion (ppt) to a maximum of 50 ppt. The PCB concentration limit may derive from 40 CFR Part 761 which states that biosolids exceeding 50 parts per million is considered a hazardous waste.

However, EPA can still add or delete other pollutants when the Round 2 regulation is proposed. The Round 2 regulation must be proposed by December 1999 and promulgated by December 2001.

The EPA also published revisions to 40 CFR Part 261 on March 29, 1990, defining the new toxicity characteristic leaching procedure (TCLP) to be used as of September 25, 1990, in determining whether a waste is "hazardous." The revised rule also adds 25 new organic constituents to the list of toxic constituents of concern. Other changes are also made in calculations or regulatory levels of organic chemicals. The new TCLP replaces the Extraction Procedure (EP) leach test that was previously used by EPA in defining toxicity.

## State Requirements

On the State level, biosolids beneficial use/disposal is regulated by the following agencies under Cal/EPA: State Water Resources Control Board (SWRCB), Office of Environmental Health Hazard Assessment (OEHHA), Department of Toxic Substances Control (DTSC), California Integrated Waste Management Board (CIWMB), and California Air Resources Board (CARB). In general, the SWRCB, through its nine regional boards, is primarily concerned with protecting present and probable future beneficial uses of water, as required by the Porter-Cologne Water Quality Control Act (contained in Division 7 of the California Water Code).

The discharge of wastes to land in California is also regulated by the SWRCB according to the California Code of Regulations (CCR), Title 23 Waters, Chapter 15, Article 2. Chapter 15 regulations apply to the disposal of biosolids on dedicated land. Other regulations include Title 22, Chapter 11; Department of Health Services Manual of Good Practice; the California Environmental Quality Act, etc. Table 8 lists current California regulations that directly apply to biosolids use and disposal methods.

| Table 8 | California Regulations Governing Biosolids | | | | |
|---|---|---|---|---|---|
| | Federal Regulation | Land Appli-cation | Distributio n and Marketing | Monofills and Surface Disposal | Codisposal Landfill and Landfill Cover |
| CCR Title 23 §2908 | Regulates discharge of municipal solid waste to land including biosolids. | X | X | X | X |
| CCR Title 23 §2510 et. seq. | Regulates discharge of waste to land including biosolids. | X | X | X | X |
| CCR Title 23 §3680 et. seq. | Regulates operator certification for wastewater treatment operators. | | | X | |
| CCR Title 22 §66261.24 | Defines whether biosolids are hazardous. | X | X | X | X |
| PRC §40191 | Includes biosolids in the definition of solid waste. | X | X | X | X |
| PRC §42246 | Requires procuring agencies to document use of fertilizing material, including biosolids, as not harmful to public health and safety. | X | X | | |
| PRC §50002(b) | Establishes requirements for exemption of land application of biosolids that poses no threat to public health or the environment. | X | X | X | X |
| FAC §14505 | Regulates municipal biosolids as a fertilizer. | X | X | | |
| FAC §14560 | Defines biosolids with respect to its use as a fertilizer. | X | X | | |
| FAC §14682 | Prohibits distribution of adulterated fertilizing materials including biosolids. | X | X | | |

Note: CCR = California Code of Regulations
PRC = Public Resource Code
FAC = Food and Agriculture Code
IN = Incineration
LA = Land Application
LC = Landfill Cover
SD = Surface Disposal

Presently, under the California Code of Regulations (CCR), Title 22, it is the waste discharger's responsibility to determine if the waste is classified as a hazardous waste pursuant to criteria established in CCR, Title 22, Division 4.5, Chapter 11, Article 3. If a waste were marginal, the DTSC would need to classify the waste.

In addition, the office of Environmental Health Hazard Assessment (OEHHA) has both a general and specific authority under the Health and Safety Code to protect public health. This includes the responsibility of regulating the utilization and disposal of biosolids via land application. While

the OEHHA's advisory guidelines and recommendations are not regulations, they often are used in an enforcement manner through incorporation into the RWQCB's Orders (Waste Discharge Requirements).

In response to concerns over the lack of State standards or guidelines regarding the land application of biosolids, the OEHHA's Sanitary Engineering Branch published a manual in April 1983 entitled "Manual of Good Practice for Landspreading of Sewage Sludge." The purpose of the manual was to set forth "those practices in the treatment and use of sewage biosolids which have been found effective in assuring the safe and beneficial use of the material."

**State Regulations**

On the State level, the SWRCB through its RWQCBs, regulates the landspreading of biosolids. The RWQCB currently follows EPA and DHS guidelines on land application of biosolids. Application of biosolids to land must not violate the water quality standards established for the respective Water Quality Control Basin Plans developed pursuant to Section 303(e) of the Clean Water Act. Therefore, each RWQCB may act independently in establishing permitting requirements for the land application of biosolids. Serano Regional Water Quality Control Boards have issued Waste Discharge Requirements (WDRS).

In June 1995, The Central Valley Regional Water Quality Control (CVRWQCB) Board adopted "General Order No. 95-140, Reuse of Biosolids and Septage on Agricultural, Forest, and Reclamation Sites", and "Resolution No. 95-144, "Waiving Waste Discharge Requirements for the Reuse of Exceptional Quality Wastewater Treatment Plant Biosolids as Fertilizer and Soil Amendment" (Appendix A and B, respectively). These new actions provided dischargers two additional permitting options beyond the standard individual Waste Discharge Requirements (WDRs).

In April 1996, General Order No. 95-140 and Resolution 95-144 were invalidated by the State Water Resources Control Board, by the adoption of Order 96-08. Projects previously permitted through the General Order were still allowed to operate; however, in 1997, Order 96-08 was amended with Order 97-07, which allows only those sites operating under waivers submitted before April 1, 1996 to continue to operate until the General Order complies with CEQA.

The discussion below provides the general intent and major technical parts of the General Order and the Waiver, including how they differ from the 503 regulations.

**General Order.** The General Order is intended to apply to the broadest number of situations in which biosolids would be land applied. No site-specific review is required by the Board under the General Order; therefore, several limitations are included that are more stringent than the 503 regulations. The General Order would streamline the regulatory process and make it quicker for discharges to obtain a land application permit. The General Order would not override any local prohibition against land application of biosolids. A summary of the major technical components of the General Order are:

**<u>Biosolids Material Covered</u>:**

1. Class A biosolids not meeting table 3 of 40 CFR503.13
2. Class B biosolids
3. Exception Quality (EQ) biosolids
    a. Mixture contain >50% biosolids applied at 10 dry ton per acre per year or greater on at least 20 acres.
    b. Mixture contain <50% biosolids applied at 20 dry ton per acre per year or greater on at least 20 acres.

**Metals Standards:**

1. The 503 ceiling limitations, high quality limitations, and cumulative loadings are the same except molybdenum has limits set. However, the General Order requires the lifetime tracking of cumulative loadings for metals in the biosolids, even when the "high quality" metals concentrations are met ("high quality" metals are exempt from tracking in 40 CFR Part 503).

2. Calculation methods are provided to allow the applicant to compare the metals concentrations with both EPA's "dry-weight" limits and Title 22's "wet-weight" limits.

**Pathogens:**

1. Both the Class A and Class B definitions are incorporated with no changes.

2. The "waiting periods" for public access, grazing, and crop harvest are the same; animals used in the production of unpasteurized milk are not allowed to graze on the land for 12 months after application of biosolids.

3. There must be at least a 24 inch depth to groundwater at the time of application (additional requirement beyond 503).

**Vector Attraction Reduction Standards:**

1. The 503 standards are incorporated with no changes.

**Management Practices:**

1. The Department of Fish and Game must be notified if biosolids will be placed on land which has not been disturbed for two or more years. A survey of listed plants and animals must be conducted, and written approval received from DF&G for avoidance, mitigation, or incidental take of the species.

2. Discharge of tailwater or field runoff within 30 days after application of Class A and B biosolids, septage is prohibited for application areas where biosolids have not been incorporated into the soil, or where there is not sufficient vegetation to prevent movement of biosolids particles from the site.

3. Land application at rates which exceed the agronomic rate of nitrogen uptake are prohibited. For reclamation sites, however, the rates can be exceeded with approval from the appropriate Regional Board administrator.

4. Setback distances for staging areas and application sites are as follows:

| | |
|---|---|
| property lines | 10 feet |
| domestic water supply wells * | 500 feet |
| non-domestic water supply | 100 feet |
| public roads | 50 feet |
| surface waters | 100 feet |
| agricultural buildings | 10 feet |
| residential buildings | 500 feet |
| domestic water supply reservoir | 400 feet |
| primary tributary to a domestic water supply | 200 feet |
| domestic surface water supply intake | 2,000 feet |

* A lesser setback distance from domestic supply wells (100 feet minimum) may be used if the Discharger can demonstrate that the groundwater, geologic, topographic and well construction conditions are adequate to protect the public health of users of the well water.

5. Discharge of Class A biosolids shall not cause or threaten to cause pollution as defined in the California Water Code.

6. Storage, transport, or application of biosolids shall not cause a nuisance as defined in the California Water Code.

7. Surface water runoff off the permitted site resulting from irrigation of sites to which biosolids has been applied is prohibited for 30 days after application of biosolids if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation in the application area and along the path of runoff to prevent the movement of biosolids from the application site.

8. Any visible air-borne particulates leaving the application site during biosolids applications or during incorporation of biosolids at the permitted site is prohibited.

**Storage Requirements:**

1. Storage of biosolids on the ground is allowed for up to seven days at any one location within a 60 day period. The biosolids must not contain free liquids and runoff protection must be provided.

2. Flood and runoff controls are required in winter including covered storage between October 1 and April 30.

3. Storage facilities must be designed, maintained and operated to minimize leachate generation.

4. Public access must be controlled if the biosolids are Class B.

5. A storage plan must be approved by RWGCB officer if biosolids are to be stored at the site b beyond the time limits of the General Order.

6. Each biosolids' transport driver shall be trained as to the nature of their load and the proper response to accidents or spills events and carry a copy of an approved spill response plan.

**Monitoring and Reporting:**

1. There are three aspects to monitoring and reporting: pre-application reporting, semi-annual monitoring, and post-application reporting. Forms are provided with the General Order for the "Pre-Application Report" and the "Post-Application Report". Semi-annual monitoring of the biosolids is required for projects which continue for long periods of time.

   **Application Process:**

   Under the General Order, the individuals responsible for site operations retain primary responsibility for compliance with the requirements, including day-to-day operations and monitoring. Individual property owners and managers retain primary responsibility for crop selection, site restrictions, etc. The property owners have the ultimate responsibility for ensuring compliance. Under the General Order, the term "Discharger" refers to the owner/operator of the landspreading operation or facility.

1. The Discharger submits a "Notice of Intent" (NOI) and fee. The NOI describes who will be conducting the project and where the project is located. If correctly completed, submittal of the NOI grants coverage under the General Order without staff review or approval. The Regional Board has no discretion in accepting an NOI, other than to review it for completeness. The discharger must submit copies of the NOI to the Regional Board, Department of Fish and Game, and the County Health Department. A single NOI is limited to 2000 acres of land, within a 10 mile radius, and a single landowner.

2. The Discharger then submits a "Pre-Application Report" which describes how compliance with the General Order will be met (i.e. metals concentrations, loading rates, etc). The Regional Board must review and approve the "Pre-Application Report" prior to application of the biosolids.

3. Coverage under the General Order will cease upon submittal of a "Notice of Termination" and all required post-application reports.

**Waiver Resolution**

Waiver Resolution No. 95-144: The RWQCB adopted Resolution 95-144, waiving the waste discharge requirements for the beneficial reuse of biosolids that meet the 503 definition of "exceptional quality." The use of the biosolids must fully comply with all aspects of the 503 regulations, for bulk distribution or distribution in bags or containers. The biosolids must meet the 503.13 Table 3 criteria, Class A, and vector reduction requirements. Biosolids loading rates must not exceed the agronomic rates for the crop. The waiver places no restrictions on the acreage on which the biosolids are land applied, and no annual reports required.

The waiver can be issued to any qualifying dischargers and/or distributors of biosolids located within the Central Valley Region. The applicant must submit a one-page application form ("Request for Waiver of Waste Discharge Requirements for Beneficial Use of Exceptional Quality Biosolids") and pay the filing fee.

**Local Requirements**

Local enforcement agencies (LEA) may require use permits which regulate the implementation and operation of biosolids processing, handling, and beneficial use/disposal projects. Requirements vary from one jurisdiction to the next. Locally elected officials such as a board of supervisors may adopt ordinances which regulate biosolids projects. In other cases, local agencies such as the environmental health, planning, public works, or even sheriff's department may accept discretionary authority to regulate a project.

One issue that greatly impacts biosolids beneficial use/disposal sites in northern California is the passage of the Delta Protection Act in 1992. The Act declares the Sacramento-San Joaquin Delta as a natural resource of statewide, national and international significance, containing irreplaceable resources. As a result, the Delta Protection Commission adopted a ban which prohibits the location of new sewage treatment facilities and areas for disposal of sewage effluent and biosolids (including land application) within the Delta Primary Zone. The Delta Primary Zone includes portions of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties as shown. The Act was approved by members of the Delta Protection Commission.

Local counties generally require a conditional use permit that needs to be approved by the Regional Water Quality Control Board. Waste Discharge Requirements (WDRs) are issues by the regional Board. WDRs are then reviewed and subsequently approved by County agencies that have local ordinances. Several counties have recently enacted local ordinances. County ordinances typically fall under three categories: absolute ban, effective ban, and regulated use. The regulated use ordinances are typically more restrictive than state or federal requirements. An

effective ban ordinance is written in a way as to "effectively" ban the land application of biosolids. The following table lists the counties and what ordinance category that they fall under.

| Table 9 - County Biosolids Ordinance Categories | | |
|---|---|---|
| **Absolute Ban** | **Effective Ban** | **Regulated Use** |
| Sutter<br>San Joaquin<br>Stanislaus | Monterey<br>San Benito<br>Yuba<br>Glenn<br>Imperial<br>San Luis Obispo<br>San Bernadino | Solano<br>Merced<br>Yolo<br>Kern<br>Riverside<br>Tulare |

Counties not listed above do not have any specific regulations and follow the RWQCB requirements.

**County Ordinance Description**

The following is a summary of county ordinances and how they differ from the proposed GO and 40CFR503 requirements.

Riverside county

A sludge management plan needs to be developed and approved by the County Environmental Health Officer. Biosolids transportation requirements include: vehicle maintenance and repair documentation, vehicle identification. Buffer zones include a minimum 50 feet distance between adjacent property lines and biosolids land application. Other requirements will be established by resolution adopted by the Board of Supervisors.

San Bernadino County

Minimum separation distances include a 1/2 mile between biosolids land application and 1. Operating dairy with lactating cattle, 2. Any public water supply well, 3. Any live stream, lake or surface impoundment.

Tulare County

Application of all class B biosolids is prohibited. Biosolids shall not be applied to land where surface to groundwater level. Wind speeds in excess of 20 miles per hour also prevent the land application of biosolids. Biosolids land application is prohibited where depth to groundwater is less than ten feet. A land spreading plan is also required. Annual monitoring includes testing for Dioxins, Furans, PCBs, and miscellaneous organic pollutants (Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics).

Yolo County

Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time. Wind speeds in excess of 5 miles per hour also prevents the land application of biosolids. Biosolids shall not be applied on "highly erodible" land as classified by USDA Natural Resources Conservation Service (NRCS). Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biannual monitoring includes testing for Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics.

Kern County

The Kern County ordinance is currently being developed. The requirements have not yet been adopted by the County. Some of the interim requirements include: Depth to groundwater must be at least 20 feet unless shallow groundwater TDS levels exceed 3,000 mg/l and this groundwater cannot be reasonably expected to supply groundwater. Biosolids must be incorporated into the soil at least seven inches within 24 hours of application. Biosolids monitoring is required as frequently as once per month depending on the land application rate and area.

Merced County

For slopes greater than 2%, parallel disking to slope contours is required for biosolids incorporated into the soil. Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biosolids land application is limited to once per crop. Annual monitoring includes testing for Dioxins, Furans, PCBs, and miscellaneous organic pollutants (Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics).

Yolo County

Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time. Wind speeds in excess of 5 miles per hour also prevents the land application of biosolids. Biosolids shall not be applied on "highly erodible" land as classified by USDA Natural Resources Conservation Service (NRCS). Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biannual monitoring includes testing for Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics.

Solano County

Neighboring residents can file a protest which can effectively stop biosolids application. Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time.

# Appendix D. Soils, Hydrology, and Water Quality Technical Appendix

# Appendix D. Soils, Hydrology, and Water Quality Technical Appendix

This section describes the soil properties that are relevant to biosolids application; mobility, bioavailability, and potential toxicity of biosolids; and general soil characteristics in each of the nine Regional Water Quality Control Board (RWQCB) regions. In addition, this section describes hydrologic and water quality issues related to biosolids application. The fate and transport characteristics of pathogens and radioactive substances related to biosolids application are described in Chapter 5, "Public Health".

## Environmental Setting for Soils

### Summary of Soil Properties Relevant to Biosolids Application

The soil properties described below affect the suitability of a site to be used for biosolids application. Some of these properties may change as a result of biosolids application. Additionally, most of the properties are closely related to the productivity of a site for food and fiber crop production and livestock forage.

#### Texture

Probably the most significant soil property relative to biosolids application is texture (i.e., the proportions of sand-, silt-, and clay-sized particles). With other factors held constant, fine-textured soils (e.g., silty clays and clays) tend to have relatively high capacity to retain nutrients and metals, have moderate water-holding capacity (i.e., the amount of water that can be taken up by plant roots [measured as inches of water per inch of soil] or that is available throughout the root zone), have slow infiltration capacity and permeability (to water and gas movement), and be relatively difficult to till. The pH (discussed below) of fine-textured soils ranges from near neutral to alkaline. Most clayey soils are fairly resistant to erosion when the vegetation cover is removed, except on steeper slopes.

Coarse-textured soils (e.g., loamy sands) tend to have relatively low nutrient- and water-holding capacities, have low native fertility, have rapid infiltration capacity and permeability, and be easily tillable. Many coarse-textured soils have low organic matter

content. The pH of coarse-textured soils ranges from near neutral to acidic. Sandy soils are among the soils most subject to water erosion and high percolation rates.

Medium-textured soils (e.g., loams and silt loams) generally have fertility and hydrologic characteristics intermediate between fine- and coarse-textured soils, except that they have the highest available water-holding capacity. Medium-textured soils, particularly those with high organic matter content, are generally resistant to erosion on gentle to moderate slopes.

## Cation Exchange Capacity

Cation exchange capacity (CEC) is a measure of a soil's net negative charge and a measure of a soil's capacity to retain and release cations (i.e., positively charged ions) for uptake by plant roots. Cations (e.g., calcium and ammonium) can be essential for plant growth in small concentrations but may be toxic in larger concentrations (e.g., molybdenum, zinc, and copper). Some trace elements, such as lead, are not required in any amount but may be toxic to plants and the animals that feed on them. The level of CEC is controlled primarily by the amount and type of clay mineral in the soil and the content of humus (highly decomposed organic matter) in the soil. In coarse-textured soils, humus may provide most of the soil's CEC. For a given quantity (i.e., weight) of soil, the CEC of humus is typically several times that of most pure clays. Clayey soil commonly has a CEC more than fives times that of sandy soil. A high CEC is desirable in soil because it lessens or prevents essential nutrient loss from the soil by leaching (Donahue et al. 1983). Soils with high CEC can also immobilize heavy metals such as copper and lead by binding the negatively charged metal anions to cation exchange sites associated with the clay minerals and organic matter.

## Organic Matter

Organic matter, another important property of soil, enhances the physical condition of surface soil layers by binding together individual soil particles into larger aggregates, which give structure to the soil. Organic matter especially benefits the structure of sandy soils. Improved soil structure creates large pores through which gases and water can move and roots can penetrate. Accordingly, soils with good structure tend to have a lower bulk density and be more permeable than soils with poor structure. A well-aerated, permeable soil is usually more productive than a poorly aerated soil. High permeability tends to improve a soil's infiltration capacity and make the soil easier to till (Donahue et al. 1983). Further, soils with large, stable aggregates (i.e., well-structured soils) are more resistant to erosion than soils with poor structure (National Academy of Sciences 1996). Organic matter also improves tillability (particularly among coarse- and fine-textured soils) by promoting good structure of surface layers (Donahue et al. 1983).

Soil organic matter content also affects the capacity of the soil to retain water and many soluble nutrients and metals, particularly in coarse-textured soils. Organic matter is also the source of most of the nitrogen in an unfertilized soil and can be an appreciable source of phosphorus and sulfur. Soil microbes use organic matter as a food source (Donahue et al. 1983).

## pH

Soil pH is a measure of the acidity or alkalinity of a soil. Nearly all California soils have a pH ranging from 5.0 to 8.5; a pH of 7.0 is considered neutral. A low pH (e.g., an acidic soil with a pH of 5.5) suggests that soil nutrient concentrations and microbial activity are low (Tucker et al. 1987). Bacteria that decompose organic matter and therefore release nitrogen and other nutrients for plant growth are less active in strongly acidic soils. In strongly acidic soils, most heavy metals and some nutrients are soluble and aluminum and manganese may be present in toxic concentrations. A high pH (e.g., an alkaline soil with a pH of 8.0) suggests that concentrations of some soil nutrients (particularly calcium and magnesium) are high; some soils with high pH have high concentrations of soluble salts, which can limit plant growth and affect the type of crops that can be grown on a site (Donahue et al. 1983). High pH levels can also bind soluble phosphorus, making it unavailable for plant growth. Iron (and, to a lesser degree, zinc) may be insufficient to allow sensitive crop species to grow in high-pH, calcareous soils (Tucker et al. 1987). Soil pH also greatly affects the solubility of minerals and many heavy metals, and therefore affects their availability for plant growth and uptake in biomass and their potential to be leached from the soil profile. A slightly acidic condition (e.g., pH 6.5) is best for many agricultural crops because overall, macronutrients and micronutrients are most available for plant uptake under slightly acidic conditions (Donahue et al. 1983). Maintaining neutral to slightly alkaline conditions is often recommended for soils if high levels of heavy metals are a concern because the metals tend to be less mobile at these pH conditions.

## Salinity

Salinity refers to the salt content of soil. Salts are dissolved mineral substances, including sulfates, chlorides, carbonates, and bicarbonates of the elements sodium, calcium, magnesium, and potassium. Although a low level of salts in the soil is desirable, high salinity levels (commonly above an electrical conductivity of 4 decisiemens per meter for many crops) make it difficult for plant roots to extract water from the soil, which may reduce growth rates. High salt concentrations may delay seed germination or completely inhibit germination. The deleterious effects of high salt concentrations are most pronounced among young plants (Donahue et al. 1983).

## Bulk Density

Bulk density refers to the mass of dry soil per unit of volume, usually measured in grams per cubic centimeter. Bulk density affects permeability and root penetration and is affected by texture, structure, organic matter content, and soil management practices. Because of differences in these factors, soils with different bulk densities may be effectively equal with respect to permeability and root penetration (Donahue et al. 1983).

## Depth

Soil depth affects the capacity of a soil to retain nutrients and metals. References to soil depth pertain to the depth of a soil over rock or a restrictive layer that prevents significant root penetration, such as a hardpan or a very dense claypan. Soils less than 20 inches deep are considered shallow, and soils more than 60 inches deep are considered very deep (U.S. Department of Agriculture 1993).

## Organisms

Soil microorganisms, including bacteria, actinomycetes, fungi, algae, and protozoa, play an important role in the decomposition of organic matter (including biosolids) (Phung et al. 1978) and the cycling of plant nutrients, such as nitrogen, phosphorus, and sulfur (National Academy of Sciences 1996). Some evidence suggests that the rate of decomposition of organic matter by microorganisms may be reduced in the presence of high heavy metal concentrations (Sommers et al. 1976). Soil organisms such as earthworms play an important role in breaking up organic materials and mixing them into the soil (Phung et al. 1978).

## Drainage

A soil's drainage class is controlled primarily by permeability, seasonal depth of **[or "to"?]** the water table, and slope. At the dry end of the drainage spectrum, soils that are excessively drained tend to be coarse textured, not influenced by high groundwater, and located on steep slopes. Soils that are very poorly drained typically have groundwater at or near the surface for much of the growing season and are located in level or depressional areas (U.S. Department of Agriculture 1993). Sometimes shallow subsurface restrictive layers, such as claypans and hardpans, cause a perched water table (i.e., an area of groundwater that rests on an impermeable layer, preventing water from percolating downward) in the surface soil layers.

Decomposition of organic matter (including biosolids) is typically not restricted by soil moisture if the moisture content is maintained at approximately 30%–90% of the water-

holding capacity of the soil. Conversely, saturated conditions (such as in a poorly drained soil) reduce the available oxygen, which can slow microbial decomposition rates. Soil microorganisms become essentially inactive when the soil moisture content drops below the level at which plants wilt (Phung et al. 1978).

### Erodibility

Soils most susceptible to erosion (detached and entrained by water and wind) are those high in coarse silt- and fine sand-sized particles (Donahue et al. 1983), particularly when organic matter content is low and soil structure is weak or nonexistent. Erosion is usually of concern when the vegetative cover is removed or reduced, the soil is otherwise disturbed, or both of these conditions exist. Water erosion typically is a less pressing concern on shallow slopes (i.e., 10% or less), such as those generally used for biosolids application, because typically there is little runoff of rainfall. Erosion caused by water is also more easily controlled by maintaining a good vegetative cover. Significant wind erosion can occur in areas with a combination of high winds, removed or disturbed vegetation, fine sandy or silty textures, and low organic matter content.

The erosion rate of a particular soil in the absence of human activities is referred to as the natural or geologic erosion rate. Erosion in excess of the natural erosion rate is called accelerated erosion, which is usually caused by human activities such as cultivation, grazing, and grading.

## Summary of Soil Properties by RWQCB Region

Soil conditions in California are extremely variable and reflect a diversity of geologic, topographic, climatic, and vegetative conditions that influence soil formation and composition. For the purposes of this document, broad generalizations can be made about the properties of soils in each RWQCB region that may influence or be influenced by biosolids application. Soil properties that are specific to either a particular region or the biosolids application process are provided, where this information is readily available.

### Information Sources

Unless otherwise specified, the following summaries of soil properties in each region were based on Major Land Resource Areas defined by the U.S. Soil Conservation Service (1981) (now the U.S. Natural Resources Conservation Service). Major Land Resource Areas (MLRAs) consist of large areas that are broadly similar with respect to soils, geology, climate, water resources, and land use. Sixteen MLRAs have been designated in the state. MLRA information is appropriate for statewide resource

description and planning. This information was supplemented by a general soil map of the state (Pacific Gas and Electric Company 1989) and other literature. Because biosolids are almost always applied on moderate to shallow slopes (i.e., up to approximately 15%), only the types of soil found in valleys, basins, terraces, and alluvial fans are described below.

Soils in the geographic areas excluded from the GO that otherwise would have been included in the discussion (i.e., the Sacramento-San Joaquin River Delta, Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

The soils within each RWQCB region were identified by overlaying a map of the region's boundaries over the MLRA map. Table D-1 shows soil properties in California delineated by RWQCB basin areas.

## Typical Soil Properties in Forested Areas

Soil properties in forested areas of the state that are suitable for biosolids application (i.e., have less than approximately 15% slope) differ from soils typically used for agricultural land application primarily in that they are underlain by bedrock and are relatively shallow. Forest soils in California tend to have neutral to acidic pH. The organic matter content ranges from relatively low to high (for mineral soils) but is usually concentrated in the upper soil layers. A layer of plant litter often rests on the soil surface. Forest soils are often more strongly leached of nutrients than agricultural soils. The texture typically ranges from clay loam to sandy loam and the soils often have rock fragments in the profile. Except in meadow areas (which typically would not be considered as suitable areas for biosolids application because they may qualify as jurisdictional wetlands) and in seep areas, groundwater tends to be deep (Colwell 1979, U.S. Soil Conservation Service 1981).

## Typical Soil Properties at Mined Sites

Conditions at mined sites differ from those at agricultural land application sites in that the native soil material has typically been partially or entirely removed or mixed with less productive subsoil material. Although soil and site conditions may vary widely according to the type of mine, the soil materials at such sites often have low nutrient- and water-holding capacities, high rock-fragment content, low organic matter content, low pH, and high concentrations of trace metals. These conditions result in unfavorable conditions for seed germination and plant growth, making revegetation efforts difficult (Reed and Crites 1984). Slopes may be steep at some mined sites.

## Table D-1
## Summary of Predominant Soil Characteristics in Each RWQCB Region

| RWQCB Region | Depth | Texture | Drainage | Organic Matter Content | Acidity/ Alkalinity | Other Distinguishing Characteristics |
|---|---|---|---|---|---|---|
| 1 | shallow to deep (the former sometimes over a subsurface cemented hardpan) | sandy to clayey | well drained to poorly drained | low to high | moderately acid to neutral | Owing to the presence of serpentine rocks, upland soils in the region contain high amounts of nickel and copper (Holmgren et al. 1993); gently sloping alluvial soils below the serpentine watersheds may also contain high background concentrations of the two metals. |
| 2 | deep | loamy to clayey | well drained to poorly drained | moderate to high | slightly acid to slightly alkaline | |
| 3 | very deep | sandy to clayey | well drained to poorly drained | moderate to high | slightly acid to slightly alkaline | Some alluvial soils, lying below certain areas of Monterey shale, in the Salinas Valley have been reported to contain high background concentrations of cadmium (Holmgren et al. 1993). |
| 4 | shallow to deep (the former sometimes over a subsurface cemented hardpan) | loamy | well drained | moderate to high | slightly acid to slightly alkaline | |

## Table D-1. Continued

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | shallow to deep (the former sometimes over a subsurface cemented hardpan) | sandy (particularly along the eastern side of the San Joaquin Valley) to clayey | well drained to poorly drained | moderate | moderately acid to alkaline | Some areas along the western side of the San Joaquin Valley, have high selenium, boron, molybdenum, and arsenic (the latter in the extreme southern end) and salt concentrations (all of which occur naturally in the soils) in soils and groundwater, and high groundwater levels (San Joaquin Valley Drainage Program 1990). High concentrations of mercury have been identified in soils of the Panoche and Cantua Creeks alluvial fans (Tidball et al. 1986). |
| 6 | moderately deep | sandy to loamy | low rainfall causes the soils to be droughty | low | neutral to alkaline | Some soils have high calcium content |
| 7 | moderately deep to very deep | sandy to clayey | low rainfall causes the soils to be droughty | low | neutral to alkaline | Some areas have high salt (Letey et al. 1996) and calcium content. Wind erosion is a major issue in this region. |
| 8 | shallow to deep (the former sometimes over a subsurface cemented hardpan) | loamy | well drained | moderate to high | slightly acid to slightly alkaline | |
| 9 | shallow to deep (the former sometimes over a subsurface cemented hardpan) | sandy to loamy | well drained | low to moderate | slightly acid to slightly alkaline | |

_____

Notes:

1) The information provided in this table consists of generalizations about the predominant soils occurring in each RWQCB region; soils with characteristics different than those described above may also occur.

2) Because biosolids are nearly always applied on moderate to more shallow slopes (i.e., up to approximately 15%), only those soils occurring in valleys, basins, terraces, and alluvial fans are described. Additionally, soils occurring in the larger geographic areas excluded from the GO that otherwise would have been

included in the table (i.e., the Sacramento-San Joaquin Delta, the Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

Sources: U.S. Department of Agriculture Soil Conservation Service 1981, Pacific Gas and Electric Company 1989.

### Typical Soil Requirements of Horticultural Operations

In California, biosolids are not widely used for horticultural plantings. It is expected that the most frequent uses would be in large parkland or golf course settings or in large-scale nursery operations. These settings could occur throughout the state but would likely be more common in valley or low foothill areas with relatively deep soils, moderate to shallow slopes (less than 15%), and a wide range of soil textures (coarse silts to clay loams and clays). Because horticultural areas are usually selected for their ability to support planted vegetation, they usually have low to medium organic content, are well drained, and have a pH ranging from slightly alkaline to slightly acidic. Soil conditions that would be unfavorable for seed germination and plant growth would be avoided. Where new parks or golf courses are being developed, biosolids may be applied to soil material imported from offsite. These soils may lack profile development and have little or no remaining soil structure.

# Environmental Setting for Hydrology

## Surface Water Hydrology

The surface waters of California can best be characterized by regions of similar hydrologic character. Six separate hydrologic regions have been designated in the state, based on divisions established by the California Department of Water Resources (DWR) (1994a). Each of these regions exhibits distinct precipitation, runoff, and geologic conditions. Because of vast differences in climate, vegetation, and geography between these regions, the state possesses wide-ranging variations in seasonal weather patterns, precipitation, and runoff potential. A variety of database resources are available, and new information is constantly being added that allows evaluation of site-specific hydrologic characteristics in California. With the advent and expansion of available Internet resources, computer databases now include extensive data from geographic information systems (GIS) databases such as those maintained by the California Teale Data Center for topography, watershed boundaries, surface water and groundwater resources, designated floodplains, geological features, soil characteristics, and vegetative cover (California Teale Data Center 1999). Databases are also available for specific streamflow information for gaged rivers in California on the U.S. Geological Survey Internet servers (U.S. Geological Survey 1999a). The DWR operates the California Irrigation Management Information System (CIMIS), a program of real-time atmospheric and precipitation data aimed at water management for agricultural operations (California Irrigation Management Information System 1999). DWR also maintains the California Data Exchange Center (CDEC) program of real-time data collection for river, reservoir, and snowpack information focused on water supply management (California Data Exchange Center 1999).

### Characteristics of California Watersheds

High amounts of variation in climate, precipitation, and runoff characteristics dominate California watersheds. The North Coast region, for example, can receive up to 200 inches of rainfall per year, whereas some areas of the Colorado Desert region in the south part of the state receive less than 2 inches per year (Mount 1995). These patterns, combined with other regional factors, determine the amount and type of runoff emanating from the area, the rate of deep percolation and aquifer recharge, and the potential for flooding to occur. Table D-2 shows the seasonal patterns, precipitation and runoff characteristics of the six regions.

**Water Supply Issues.** The state is traversed by numerous facilities and infrastructure to ensure that water supplies are reliable. A water service system's reliability is based on that system's ability, through proper management, to meet demand regardless of fluctuations in supply, including shortages during periods of drought (California Department of Water Resources 1994a).

Of the 62.4 million acre-feet (maf) of total projected available supplies for the year 2000 (non-drought scenario), 55.1 maf is surface water for local and long-range deliveries and dedicated natural flow. A significant portion of the surface water originating in northern California is transferred through Central Valley Project (federal) and State Water Project operations to southern California from the Sacramento-San Joaquin River Delta, from the Mono-Owens Lake area in eastern California, and from the Colorado River (California Department of Water Resources 1994a). Table D-3 describes the major watersheds, surface water resources, and conveyance facilities in each Regional Water Quality Control Board (RWQCB) region.

Legislative and policy changes in federal and state deliveries and uses over the past 8–10 years have created a greater demand for optimal management of the state's water resources. More of the water is designated for environmental purposes, and mandates to reduce impaired water bodies have been reinforced. To meet these increased standards, long-term, comprehensive management programs are being developed and implemented throughout the state. Conserving water and maintaining the quality of existing water supplies are now the focuses for resource management and regulatory agencies, water supply purveyors, treatment plant operators, and users.

## Groundwater Hydrology

Approximately 40% of the total land area of the state is underlain by groundwater basins. It is estimated that the storage capacity of these basins reaches totals of approximately

## Table D-2.
## Watershed Characteristics of California

| Region | Seasonal Patterns | Runoff Characteristics | Precipitation |
|---|---|---|---|
| North Coast (Region 1) | Inland: Distinct rainy, cool winters and hot, dry summers.<br>Coastal: Cool and wet year round with little temperature variation. | Highest peak discharges recorded in state, with highest total sediment yields. | Dominated by rainfall; average annual precipitation in region is 53 inches. |
| Sacramento, San Joaquin, and Tulare Lake (Region 5) | Valley: Hot, dry summers and cool, wet winters. Mountains: Mild summers with intermittent thundershowers, heavy winter snowfalls above 5,000 feet. | Prolonged spring runoff fed by Sierra Nevada snowpack; low sediment yields due to widespread vegetation and stable rock types/soils; locally high sediment yields due to land uses (e.g., logging, grazing, and urbanization). | Valleys receive winter rainfall, and mountains receive moderate to heavy snowfall; total average annual precipitation ranges from 36 inches in the Sacramento River region to 13-14 inches for the San Joaquin and Tulare Lake regions. |
| San Francisco Bay and Central Coast (Regions 2 and 3) | Coast: Cool and foggy year round with rain in the winter; small seasonal temperature variations<br>Inland areas: Warm, dry summers with cool, rainy winters. | High peak runoff due to small, steep watersheds; local rivers susceptible to severe flooding during high-rainfall events; some watersheds produce high sediment yields due to unstable rock types/soils | Precipitation from rainfall, with insignificant snowfall; northern area - average annual precipitation is 31 inches, greater than 50 inches in some areas; southern area - average precipitation is 20 inches |
| North and South Lahontan (Region 6) | Valleys: Semi-arid, high-desert terrain; hot, dry summers with locally intense thunderstorms; mild, dry winters<br>Mountains: Cool, mild summers; cold winters with regionally heavy snowfall | Valleys: High peak runoff in ephemeral drainages; watersheds except Owens River are short and steep ephemeral drainages; stable rock types/ soils result in low, coarse sediment yields<br>Mountains: Extended spring runoff with locally high sediment yields in Sierra Nevada. | Valleys: Low to moderate precipitation totals due to rainshadow effects of Sierra Nevada and Cascade Mountains<br>Mountains: Regionally heavy winter snowfall and intense summer thunderstorms; average annual precipitation ranges from 8 inches in the south to 32 inches in the north |

## Table D-2. Continued

| Region | Seasonal Patterns | Runoff Characteristics | Precipitation |
|---|---|---|---|
| South Coast (Regions 4, 8, and 9) | Mediterranean climate with several dry years interrupted by infrequent high precipitation years; warm, dry summers and mild, wet winters; inland summer temperatures can exceed 90ºF; intense subtropical storms | Watersheds are largely ephemeral and fed by rainfall; rivers susceptible to frequent flooding due to peak discharge events; sediment yields are locally high due to intense urbanization, low vegetation, and unstable soils; debris flows and mudflows frequent in some smaller drainages | High rainfall with insignificant snowfall contribution; locally heavy storms have the highest 24-hour rainfall totals in the state; average annual precipitation is 18.5 inches |
| Colorado Desert (Region 7) | Arid desert region with hot, dry summers and mild winters; rainfall is limited to a few storms per year | Low runoff due to limited rainfall, but locally heavy during infrequent storm events; overall sediment yields are low but produce debris flows during storms | All precipitation falls in the form of rain; region has the lowest yearly precipitation totals in the state, with some areas receiving less than 2 inches; average regional rainfall is 5.5 inches. |

Sources: Mount 1995; California Department of Water Resources 1994a; California Regional Water Quality Control Board 1994.

# Table D-3.
# Principal Surface Water Resources, Water Supply Facilities, and Beneficial Uses for Each RWQCB Region



| Region | Primary Basins or Contributing Rivers | Major Storage Facilities (Reservoirs) | Major Conveyance Facilities | Sensitive Beneficial Uses | Central Valley Project (CVP) Supply Status | State Water Project (SWP) Supply Status | Notes |
|---|---|---|---|---|---|---|---|
| 1- North Coast | Klamath River Basin, North Coast Basin | Clair Engle (Trinity), Upper Klamath (Oregon), Clear Lake, Lake Sonoma Warm Springs Dam | Canal from Clair Engle Reservoir to northern Sacramento Valley | Municipal, domestic and industrial supply, recreation, maintenance of resident and anadromous fisheries, national wildlife refuges | No CVP supplies to area | No SWP supplies to area | Area contains most of the state's wild and scenic rivers. 95% of supplies dedicated to environmental use. |
| 2 - San Francisco Bay | Numerous local surface water drainages | Calaveras, Leroy Anderson, Del Valle, Briones, Crystal Springs | Putah South Canal, Sonoma-Petaluma Aqueducts, North Bay Aqueduct, Mokelumne Aqueduct, Contra Costa Canal, South Bay Aqueduct, Hetch Hetchy Aqueduct, San Felipe Unit | Municipal, domestic and industrial supply, groundwater recharge, water recreation , wildlife, cold and warm freshwater habitat, fish migration and spawning, estuarine habitat | CVP water delivered through the Contra Costa Canal to the Contra Costa Water District and through the San Felipe Project to the Santa Clara Water District. About 50% is used for recharge, the rest is used for direct supply | SWP water delivered through the South Bay Aqueduct to the Santa Clara Valley Water District for municipal and industrial supply, agricultural deliveries, and groundwater recharge | 76% of supplies are for dedicated natural flow |

| Region | Primary Basins or Contributing Rivers | Major Storage Facilities (Reservoirs) | Major Conveyance Facilities | Sensitive Beneficial Uses | Central Valley Project (CVP) Supply Status | State Water Project (SWP) Supply Status | Notes |
|---|---|---|---|---|---|---|---|
| 3 - Central Coast | Numerous local surface water drainages | San Antonio, Nacimiento, Cuyama River, Santa Ynez. Over approximately 60 reservoirs. Most are privately owned | San Felipe Unit, Coastal Branch Aqueduct | Wildlife, municipal, domestic, and industrial supply, recreation, rare, threatened or endangered species | CVP water delivered through the San Felipe Unit | SWP water delivered through the Coastal Branch Aqueduct | 82% of water supplies from groundwater, remainder of non-CVP/SWP supplies from local surface water and storage facilities. |
| 4 - Los Angeles | Santa Clara River, Los Angeles River, San Gabriel River | Castaic Lake, Lake Piru, Pyramid Lake, Lake Casitas | Los Angeles Aqueduct, California Aqueduct | Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species | No CVP deliveries in region | SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region. | Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources. |

# Table D-3. Continued



| Region | Primary Basins or Contributing Rivers | Major Storage Facilities (Reservoirs) | Major Conveyance Facilities | Sensitive Beneficial Uses | Central Valley Project (CVP) Supply Status | State Water Project (SWP) Supply Status | Notes |
|---|---|---|---|---|---|---|---|
| 5 - Central Valley | Sacramento River Basin and, San Joaquin River Basin (both contain numerous important watersheds) | Numerous large reservoirs in the Sierra range (capacities of 200 thousand acre-feet or more); several smaller reservoirs along east side of coast range | California Aqueduct (i.e., SWP), Delta-Mendota Canal (i.e., CVP), Friant-Kern Canal, numerous canals and ditches on valley floor | Agriculture, wildlife habitat, fish migration and spawning, preservation of rare and endangered species, warm and cold freshwater habitat, municipal, domestic, and industrial, | Projected water supplies from CVP operations are projected to be about 7.4 million acre-feet in the year 2000 (average year) | SWP supplies insignificant in northern and central valleys. Tulare Lake region is projected to receive just over 1 million acre-feet of water in the year 2000 (average year) | Other local surface water and groundwater supplies are projected to be 13.7 million acre-feet in the year 2000 (average year). Region supplies over 2/3 of the state's drinking water needs. |
| 6 - Lahontan Region | Truckee River, Carson River, Walker River, Owens River, Amargosa River, Mojave River | Stampede, Lake Tahoe, Lake Crowley | California Aqueduct (east and west branches), Los Angeles Aqueduct | Agriculture, wildlife habitat, warm and cold freshwater habitat, municipal, domestic, and industrial | No CVP deliveries in region | Supplies from SWP facilities are projected to total about 24% of all developed water supplies in South Lahontan. No SWP facilities in North Lahontan. | North Lahontan receives 74% of all water supplies from local surface water, and 23% from groundwater. South Lahontan receives 10% of supplies from local surface water, 52% from groundwater, and 23% is dedicated natural flow |

# Table D-3. Continued



| Region | Primary Basins or Contributing Rivers | Major Storage Facilities (Reservoirs) | Major Conveyance Facilities | Sensitive Beneficial Uses | Central Valley Project (CVP) Supply Status | State Water Project (SWP) Supply Status | Notes |
|---|---|---|---|---|---|---|---|
| 7 - Colorado River Basin | Colorado River, White Water River | Salton Sea - saline | Colorado River Aqueduct, California Aqueduct, Coachella Canal, East Highline Canal, Westside Canal | Agriculture, municipal and industrial, recreation | No CVP deliveries in region | Small amount (2% of all supplies) provided through SWP deliveries | 96% of all water supplies delivered to the region are conveyed from the Colorado River Aqueduct (year 2000 projection, non-drought scenario) |
| 8 - Santa Ana | Santa Ana River | Lake Perris, Lake Mathews, Lake Elsinore, Seven Oaks, Prado | Colorado River Aqueduct | Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species | No CVP deliveries in region | SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region. | Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources. |

## Table D-3. Continued



| Region | Primary Basins or Contributing Rivers | Major Storage Facilities (Reservoirs) | Major Conveyance Facilities | Sensitive Beneficial Uses | Central Valley Project (CVP) Supply Status | State Water Project (SWP) Supply Status | Notes |
|---|---|---|---|---|---|---|---|
| 9 - San Diego | San Luis Rey River, San Diego River | San Vicente Reservoir, Lower Otay Lake, El Capitan, | Colorado River Aqueduct, San Diego Aqueducts | Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species | No CVP deliveries in region | SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region. | Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources. |

1.3 billion acre-feet of water, and many of them are estimated to be full or nearly full. The fraction of water that is usable from these basins, about 143 million acre-feet, is still more than three times the capacity totals of the state surface storage reservoirs.

Many of the California groundwater basins are located in arid valleys and are recharged by percolation of rainfall and surface water flows. Recharge occurs more readily in areas of coarse sediments, which are usually located near the alluvial fans associated with mountain ranges. Percolation in southern California occurs only during periods of intense precipitation, whereas northern California groundwater basins often receive direct recharge from annual precipitation (California Department of Water Resources 1975). The location and extent of impermeable confining layers in the alluvial deposits that contain the aquifers play a major role in the amount and rate of recharge of percolating water, and overall quality of the groundwater.

### Groundwater Basins

There are about 250 important groundwater basins statewide, supplying about 40% of the state's applied water needs. Statewide, more than 15 million acre-feet (maf) of groundwater are extracted for use in agricultural, municipal, and industrial applications. Table D-4 identifies California's major groundwater basins by region. For types of sensitive beneficial uses of water by region, refer to Table D-2.

# Water Quality Setting

## Surface Water and Groundwater

State and federal water quality standards are established to achieve a level of quality that provides the highest benefit for all users. Therefore, water resources need to be protected from impairments that result from waste discharges. By assessing and identifying beneficial uses in a given area, water quality standards and treatment levels can be established to best meet the needs of that area. The primary beneficial uses that are evaluated for regulatory compliance (refer to "Regulatory Framework" below) include aquatic life support, fish consumption, primary-contact recreational activities such as swimming, secondary-contact recreational activities such as wading, drinking water supply, and agricultural/industrial supply. The costs of remedial cleanup actions and potential adverse environmental effects of poor water quality can be considerable and can affect the amount of water available for beneficial uses. Increased storage, treatment, and handling costs; reduced crop yields; and harmful effects on fish and wildlife are examples of the adverse effects of impaired waters.

## Table D-4. Major Groundwater Basins of California

| Region | Major Groundwater Basins | Extraction (ac-ft/yr) |
|---|---|---|
| 1 - North Coast | Tule Lake, Siskiyou Butte Valley, Shasta Valley, Scott River Valley, Hoopa Valley, Smith River Plain, Mad River Valley, Eureka Plain, Eel River Basin, Covelo Round Valley, Mendocino County | 242,338 |
| 2 - San Francisco Bay | Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, Santa Clara Valley, Livermore Valley, Marin County, San Mateo County | 190,128 |
| 3 - Central Coast | Soquel Aptos, Pajaro Basin, Salinas Basin, S. Santa Clara - Hollister, Carmel Valley-Seaside, Arroyo Grande/Nipomo Mesa, Cuyama Valley, San Antonio, Santa Ynez Valley, South Central Coast, Upper Salinas, San Luis Obispo | 1,075,800 |
| 4 - Los Angeles | Central Basin, West Coast Basin, San Fernando Valley, Raymond Basin, San Gabriel, Upper Ojai Valley, Fox Canyon | 808,000 |
| 5 - Central Valley | Butte County, Colusa County, Tehama County, Glenn County, Sacramento County, Western Placer County, Yuba County, Sutter County, Eastern Solano County, Yolo County, Sierra Valley, Goose Lake Basin, Big Valley, Fall River Valley, Redding Basin, Almanor Lake Basin, Upper Lake Basin, Lake County/Scotts Valley, Kelseyville, Valley Basin, Coyote Valley, Middletown-Colalyomi Valley, San Joaquin County, Modesto Basin, Turlock Basin, Merced Basin, Chowchilla Basin, Madera Basin, Delta Mendota, Kings Basin, Tulare Lake Basin, Kaweah Basin, Tule Basin, Westside Basin, Pleasant Valley Basin, Kern County Basin | 8,302,100 |
| 6 - Lahontan | Surprise Valley, Honey Lake Valley, Long Valley Basin, Thermo-Madeline Plains, Willow Creek Valley, Secret Valley, Owens Valley, Death Valley, Mojave River Valley, Antelope Valley | 397,200 |
| 7 - Colorado River | Warren Valley, Coachella Valley, Cuckwalla | 114,740 |
| 8 - Santa Ana | Orange County (also in Region 9), San Bernardino Basin Area, Riverside Basin Areas 1 and 2, Colton Basin | 98,180 |
| 9 - San Diego | Temecula Valley, San Juan Valley, El Cajon Valley, Sweetwater Valley, Otay Valley, Warner Valley, San Luis Ray | 34,000* |

*Total does not include Warner Valley or San Luis Ray - extraction rates unknown.
Sources: California Department of Water Resources (1994a), and California Department of Water Resources (1975).

Water quality is monitored through a variety of federal, state, and local programs. The state evaluates current water quality conditions and prioritizes funding efforts for protection, cleanup, and monitoring programs through individual water quality assessments, which are compiled into the state's Section 305(b) reporting process mandated under the federal Clean Water Act (California State Water Resources Control Board 1996). The Section 305(b) report includes the Section 303(d) lists, which are named in reference to the Clean Water Act section that mandates their preparation. The Section 303(d) lists identify water bodies that do not meet applicable water quality standards for designated beneficial uses with technology-based controls for waste discharges. Several other major ongoing water quality monitoring programs include the State Toxics Substance Control Monitoring Program (California State Water Resources Control Board 1999) and monitoring that is required to be conducted in the San Joaquin-Sacramento River Delta to manage SWP and CVP operations in the Central Valley (California Department of Water Resources 1994b, California Department of Water Resources 1999). Databases are also available for specific water quality information for many rivers, lakes, and groundwater wells in California on the U.S. Environmental Protection Agency's (EPA's) STORET data retrieval system (EarthInfo Inc. 1994, U.S. Environmental Protection Agency 1999) and U.S. Geological Survey Internet servers (U.S. Geological Survey 1999b).

Water quality issues differ depending on the location and type of water resource, size and extent of the watershed and water resources, location with respect to potential pollutant sources, and season and climatic factors, as well as many other interacting physical, chemical, and biological processes. Medium to large surface water bodies typically have a large capacity to assimilate waste loads of pollutants because various physical and chemical processes are effective in diluting and transforming pollutants to less harmful components. Biological processes are especially important because many chemical constituents can be absorbed by plants or animals and removed from the water or metabolized in biological tissues to less harmful substances. Consequently, water quality impairment at a large scale usually occurs in watersheds with extensive development for human activities that receive pollutants from a variety of point- and nonpoint-source pollutant discharges. Point-source pollution refers to discharges from a single location, such as a wastewater treatment plants, landfill, or industrial site. Nonpoint-source discharges are generated over a large area and result from dispersed activities such as urban stormwater runoff; mining, agricultural and forestry activities, residential septic tanks, or accidental spills.

Surface water quality is primarily dependent on seasonal flow and hydrologic patterns in combination with the mineral composition of the watershed soils and associated parent materials, topography, and sources of contaminants. During summer low-flow conditions, the water quality characteristics of most importance to aquatic life are temperature, dissolved oxygen, turbidity, biostimulatory nutrients (e.g., nitrogen and phosphorus) and nuisance algae growth, and toxic constituents such as un-ionized ammonia or residual chlorine. During higher winter streamflow conditions, water quality is influenced more by stormwater runoff and associated pollutants, such as eroded soil, oil and grease from

automobiles and paved areas, nutrients from agricultural fields and livestock boarding areas, and organic litter (e.g., leaves and grass clippings).

The most recent state Section 305(b) report indicates that most of the state's surface lakes and reservoirs, rivers and streams, freshwater wetlands, and estuaries only partially support all of their designated beneficial uses. Of the water bodies not supporting all of their uses, a small fraction fail to support the designated beneficial uses all the time. For example, 10,838 miles of the rivers and streams only partially support all beneficial uses; however, only 2,142 miles fail to support one or more beneficial uses all of the time. For lakes and reservoirs, approximately 569,000 acres only partially support beneficial uses, but only 9,670 acres fail to support one or more uses all of the time. For freshwater wetlands, approximately 107,000 acres partially support beneficial uses but there are no wetlands that do not support a beneficial use all the time. The Section 305(b) report also provides a listing of the physical or chemical constituents that cause impairment of beneficial uses. Lake and reservoir beneficial uses tend to be impaired predominantly by the presence of noxious weeds, trace metals, pesticides, and taste and odor problems, with each constituent affecting at least 100,000 acres. Approximately 30,000 acres are impaired by organic enrichment and dissolved oxygen effects, 12,000 acres are affected by nutrients and general eutrophication problems, and 12,000 acres are affected by siltation. Smaller acreages are affected by unknown toxicity, flow alterations, un-ionized ammonia, pH, or unknown causes. Rivers and streams tend to be affected by a much larger variety of constituents. Siltation, pathogens, pesticides, and trace metals dominate the list of problem constituents, with each affecting more than 3,000 miles of channels. Debris, organic enrichment, habitat alterations, salinity, suspended solids, and other trace elements each affect more than 1,000 miles of channel. Freshwater wetlands tend to be impaired primarily by trace metals, salinity, and other trace elements, with each affecting more than 8,000 acres. Flow and habitat alterations, nutrients, pesticides, and siltation contribute to the problems less sizeably. Table D-5 summarizes the major water quality issues for surface water and groundwater resources affecting each of the nine RWQCB regions.

Groundwater quality has typically been less of a concern than surface water quality because many of the useable aquifers for domestic consumption were protected by the overlying soils and geological structures. Groundwater quality, when impaired, was typically associated with percolation from landfills, leaking underground tanks, or other readily identified source of pollution. However, the public attention and regulatory focus of managing and protecting groundwater quality are increasing because nonpoint sources are known to cause widespread impairment of groundwater quality through the introduction of inorganic contaminants such as nitrates from septic tanks and agricultural fertilizer use, large scale use of pesticides and herbicides, and major concerns still exist over the potential infiltration of hazardous wastes from historical land uses. The most recent state 305(b) report indicates that approximately 20,000 acres of groundwater basins only partially support all beneficial uses, however, only 1,150 acres fail to support one or more beneficial uses all of the time. Approximately 24,800 acres of groundwater

## Table D-5. Major Water Quality Issues Affecting Beneficial Uses

| Region | Surface Water Issues | Sources | Groundwater Issues | Sources |
|---|---|---|---|---|
| 1 - North Coast | Sedimentation | Logging, Grazing | n/d | n/d |
| 2 - San Francisco Bay | Sedimentation, eutrophication, elevated fish tissue levels, dissolved solids, trace metals, habitat degradation, toxic pollutants | Irrigated farm runoff, stormwater runoff, sewage discharges, industrial manufacturing | Threat of drinking water impairment, saline intrusion, synthetic organics | Irrigated farm runoff and other nonpoint sources, overdraft, tank leaks and industrial discharges |
| 3 - Central Coast | Sedimentation, wildlife and fisheries impairments, trace metals | Irrigated farm runoff, nonpoint urban runoff | Drinking water impairment, saline intrusion, nitrates, toxic pollutants | Nonpoint source runoff, groundwater overdraft |
| 4 - Los Angeles | Elevated tissue levels, nutrients, sedimentation, high coliform count, trace metals, salinity ammonia | Industrial and urban discharges and runoff, diversions, sewage discharges, illegal dumping | Nitrates, synthetic organics, salinity, VOCs, saline intrusion | Industrial manufacturing, nonpoint source runoff, overdraft |
| 5 - Central Valley | Sedimentation, elevated fish tissue levels, eutrophication, aquatic habitat degradation, drinking water impairment, potential THM precursors | Irrigated agriculture, diversions, municipal and industrial discharges, mineral exploration and extraction | Drinking water impairment, pesticides and herbicides, agricultural impairment, VOCs | Irrigated agriculture, dairy nonpoint source pollution, agricultural wastewater, fuel tank leaks, overdraft |
| 6 - Lahontan | Recreational impacts, threats to rare and endangered species, eutrophication, sedimentation, fish kills, metals | Hydrologic modifications, grazing, mining drainage, agricultural runoff and wastewater | Drinking water impairment, salinity, VOCs | Mining drainage, overdraft, fuel tank leaks |

## Table D-5. Continued

| Region | Surface Water Issues | Sources | Groundwater Issues | Sources |
|---|---|---|---|---|
| 7 - Colorado River | Sedimentation, salinity, threat of drinking water impairment, bacteria, pesticides and herbicides | Agricultural runoff and wastewater, erosion, diversions | VOCs, threat of drinking water impairment | Overdraft, fuel tank leaks, |
| 8 - Santa Ana | Elevated shellfish tissue levels, threat of toxic pollutants, eutrophication, sedimentation, potential THM precursors, trace metals, ammonia | Agricultural wastewater, industrial discharges, urban stormwater runoff | Drinking water impairment | Agricultural nonpoint source runoff |
| 9 - San Diego | Sedimentation, eutrophication, high coliform counts, metals | Municipal and industrial discharges and runoff, agricultural irrigation returns, mining operations | Salinity, nitrates, organics, metals | Overdraft, underground storage tank leaks |

Sources: Regional Water Quality Control Board Basin Plans (California Regional Water Quality Control Boards 1995); California Water Quality Assessment Report (1996), California Department of Water Resources (1994a).
Notes: n/d = no data available;

have elevated levels of toxic constituents. A more detailed analysis of existing groundwater contamination issues associated with nitrates is presented below.

## Nitrate in Groundwater and Nitrate-Sensitive Areas

Nitrogen may be a factor in limiting the quantity of land available for biosolids application in any specific area. Nitrate contamination of groundwater has been documented throughout California (California State Water Resources Control Board 1988, California Department of Food and Agriculture 1989). Nitrogen is present in groundwater primarily in the nitrate form, although minor amounts of ammonium or nitrite may be present. The California drinking water standard or maximum contaminant level (MCL) is 45 milligrams per liter (mg/l) of nitrate ($NO_3$). This is approximately equivalent to the state and federal drinking water standard of 10 mg/l nitrate as expressed as nitrogen ($NO_3$-N).

Increased nitrate levels can be attributed to increases in population and food production. Potential sources of nitrate contamination include human and animal waste and nitrogen fertilizers used for production agriculture and in municipal areas. Nitrate is a nonpoint-source contaminant. The largest nonpoint source of nitrate contamination to groundwater is fertilizers applied in commercial farming (California State Water Resources Control Board 1988). Potential groundwater contamination from nitrates is related to many complex factors that influence biological conversions and the physical processes by which nitrates are transported through the subsurface environment. These factors include soil characteristics, crop, irrigation practices, timing and application of nitrogen, geology, climate, and hydrologic conditions. It is difficult to determine whether an observed level of nitrates in groundwater results from current or past operations. It is also difficult to quantify the level of nitrate contribution from the potential sources (agricultural, animal waste, septic, or wastewater sources).

The most recent statewide compilation of nitrate conditions in groundwater by geographic area in California was produced in 1988 (California State Water Resources Control Board 1988). The data were compiled through contact with each of the nine RWQCBs, contact with county health directors, the California Department of Health Services (DHS), the California Department of Food and Agriculture (DFA), the U.S. Geological Survey (USGS), and EPA. State and federal databases and a literature search were conducted. The SWRCB found that a large body of data exists and that special investigations were being conducted at the local level, but determined that information was not readily available for use in a statewide assessment. Large data gaps were found to exist because of the different types of monitoring programs being conducted, and there was no readily accessible centralized source for making assessments of nitrates in groundwater. For any thorough investigation of nitrate loading at the scale of an individual groundwater basin, it would be imperative to have close contact with local agencies and with the studies being conducted at this level. In general, the data and research available suggest that the highest potential for subsurface transfer of surface-applied nitrogen to groundwater would be in highly permeable, sandy soils with low

organic matter content under heavy irrigation, and that shallow wells were the water resource most susceptible to impairment. Areas that do not receive a large amount of freshwater recharge also may act as "sinks" that are more susceptible to cumulative loading of nitrates.

Figure D-1 shows well locations in areas throughout the state that have recorded nitrate levels of 45 mg/l or more during 1975–1987. Figure D-2 shows well locations where nitrate levels have been recorded in the range of 20–44 mg/l during the same period (California State Water Resources Control Board 1988). There is no statewide compilation more current than the 1988 SWRCB report, although water quality assessments prepared by each RWQCB also evaluate the level of impairment from nitrates to the designated beneficial uses for specific surface water bodies and groundwater basins.

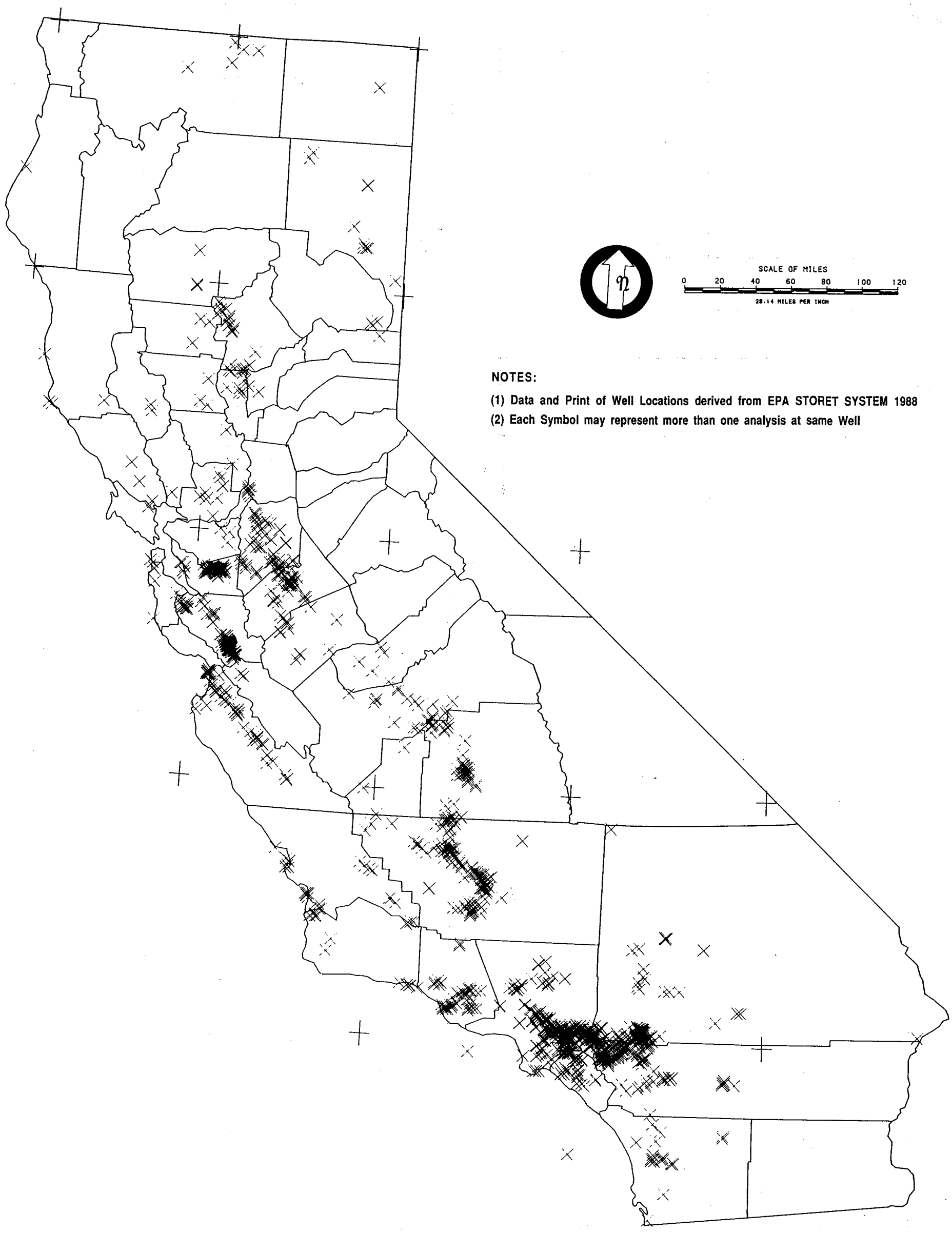
DFA has developed criteria for evaluating nitrate-sensitive areas to prioritize funding and research on nitrates (California Department of Food and Agriculture 1998). Two conditions indicate an urgent problem: a high level of nitrate contamination in groundwater and a population that depends on that water for drinking. Those two conditions depend on various factors. Soil scientists with the University of California and DFA's Fertilizer Research and Education Program (FREP) identified seven criteria for assessing the nitrate sensitivity of an area:

- **Groundwater use:** Nitrate concentration is critical if groundwater is used for domestic or animal drinking supplies.

- **Soil properties:** Sandy or other coarse-textured soils transmit water containing dissolved nitrates downward more rapidly. Also, these soils are less likely to create conditions in which nitrate turns to a gas and escapes from the soil (denitrification).

- **Irrigation practices:** Inefficient irrigation systems that lead to large volumes of subsurface drainage increase the leaching of nitrates. Typically, these are surface flow systems with long irrigation runs. Well-managed sprinkler or drip systems and surface flow systems with short runs reduce the threat of nitrate leaching to groundwater.

- **Type of crop:** Crops most likely to increase nitrate leaching are those that (1) need heavy nitrogen fertilization and frequent irrigation; (2) have high economic value, so that the cost of fertilizer is relatively small compared to the revenue produced; (3) are not harmed by excess nitrogen; and (4) tend to take up a small fraction of the nitrogen applied. Many vegetable, fruit, nut, and nursery crops fit these criteria and, therefore, have elevated potential for nitrate leaching. Those with less potential include field crops such as alfalfa, wheat, and sugar beets.




NOTES:

(1) Data and Print of Well Locations derived from EPA STORET SYSTEM 1988

(2) Each Symbol may represent more than one analysis at same Well

Source: State Water Resources Control Board 1988.

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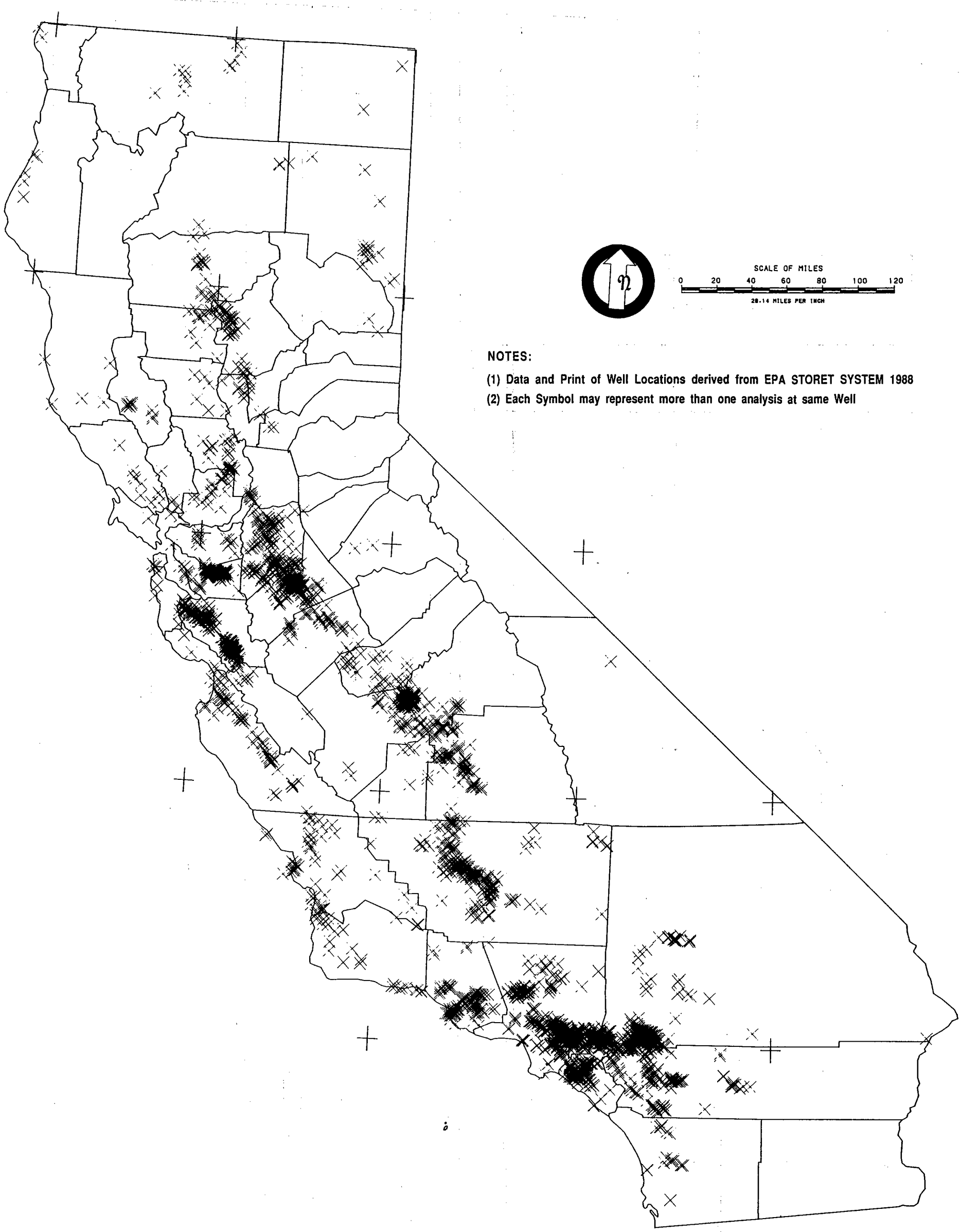
**Figure D-1**

**Well Locations where Nitrate Levels have been Recorded at 45 mg/l or Greater during the Period 1975 through 1987**




Source: State Water Resources Control Board 1988.

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**Figure D-2**
**Well Locations where Nitrate Levels have been Recorded within the Range of 20 through 44 mg/l during the Period 1975 through 1987**

- **Climate:** High total rainfall, concentrated heavy rains, and mild temperatures lead to more leaching of nitrates.

- **Distance from the root zone to groundwater:** Less distance means a more immediate problem if nitrate levels begin to increase.

- **Potential impact:** The severity of nitrate leaching also differs based on such factors as population density and availability of an alternate water supply.

The DFA's FREP initial field activities have been directed at areas based on groundwater use, soil characteristics, crop type, irrigation practices, climate, distance to groundwater, and potential impact indicate the nitrate sensitivity of an area. In general, two regions of the state, the Central Coast valleys and parts of the east side of the Central Valley, fit the above criteria.

## Mobility, Bioavailability, and Potential Toxicity of Plant Nutrients and Trace Elements in Biosolids

Several closely related issues are associated with the occurrence of nutrients, trace metals, and synthetic organic compounds in biosolids. These issues are analyzed in a fate and transport analysis, which evaluates what happens to these compounds in the soil; how their presence may affect agricultural productivity and sustainability; how they change and move through soil (to be taken up by plants and grazing animals and ultimately to enter the human food chain); and how they are removed from the immediate land application site as soil dust or eroded particles, or become dissolved and leave with surface runoff and groundwater flow.

Because all of the fate and transport mechanisms ultimately derive from the behavior of applied biosolids in the soil, this section of the EIR provides background information and an outline of some of the important chemical processes that occur in soils and influence plant uptake and the movement of compounds released from biosolids. A separate discussion is provided in Appendix E, "Public Health Technical Appendix", on uptake of biosolids-derived compounds, entry through the food chain, and related exposure mechanisms. Potential effects on soil productivity are discussed in the Chapter 4, "Land Productivity".

Most elements present in soil and taken up by plants (including nutrients and toxic metals) must be in a soluble form in the soil water (called solution phase) for recovery by plant roots and incorporation into the root mass or aboveground plant biomass. Once taken up, elements may be preferentially concentrated in various parts of the plant (e.g., leaf, petiole, flower, seed, fruit). If preferential concentrations greatly exceed background soil levels, the compounds are said to bioaccumulate. Elements contained in biosolids are

released into the solution phase by microbial decomposition of organic matter containing the elements and/or by various physical and chemical processes. For discussion purposes, elements (with the exception of pathogens, which are discussed in Chapter 5, "Public Health", and Appendix E) contained in and released following biosolids application and subsequent decomposition can be placed in three broad groups:

- Major elements and plant nutrients, which include nitrogen, phosphorus, and potassium: These and other elements, such as calcium and magnesium, are generally more soluble, occur naturally in soils in relatively large amounts, and are required in moderate to large amounts for plant growth.

- Trace elements and heavy metals, which primarily occur in biosolids in small quantities and, when released, often form sparingly soluble reaction products: Some trace elements are required for plant growth, whereas other heavy metals may be toxic to plants.

- Potentially harmful synthetic organic compounds (SOCs), which typically are found in biosolids in very small amounts and are generally not taken up by plants: The principal concern with SOCs is ingestion of plants coated with dust from biosolids sources unusually high in SOCs, as well as direct biosoids ingestion by grazing animals.

## Surface Water Runoff and Groundwater Leaching

Two of the key pathways identified in the Part 503 risk assessments were related to surface water runoff (Pathway #12) and the leaching of pollutants to groundwater (Pathway #14) from biosolids application sites. Surface water runoff from application sites can occur when rainfall exceeds the infiltration rate of the soil. Infiltration is influenced primarily by the permeability of the soil and the amount of water already stored in the soil. Runoff from application sites may cause erosion of sediments and transport of either dissolved or suspended contaminants to surface water bodies.

Leachate is water from either rainfall or irrigation that is transported through the soil. Some potential contaminants are soluble in water and may be transported in dissolved forms through the soils. Dissolved contaminants may then move through the soil and percolate to groundwater. Percolating groundwater may then move to surface water supplies or wells that provide drinking water. Complex biological, chemical, and physical processes govern how water moves through saturated and unsaturated porous materials.

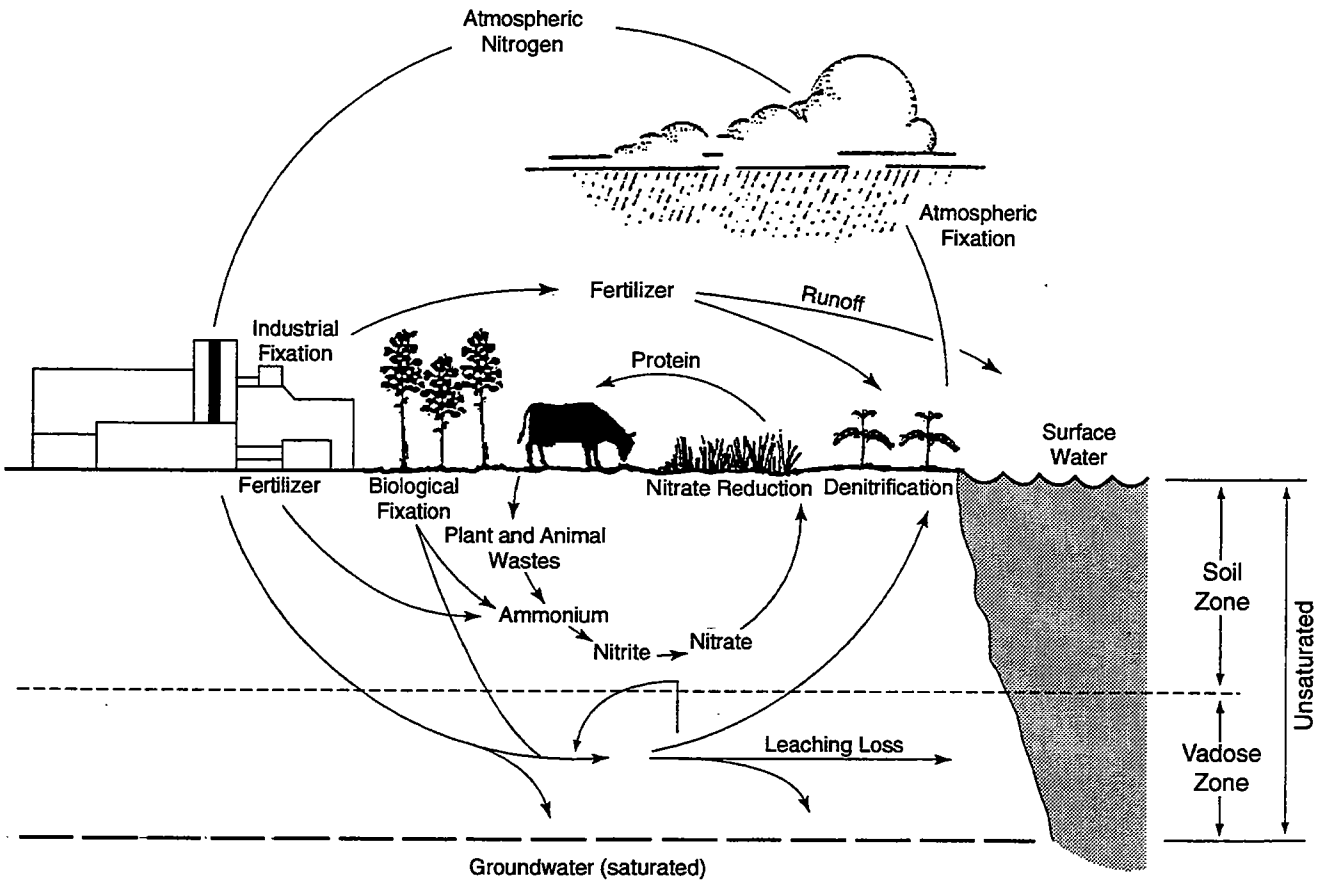
### Definitions

It is convenient to characterize the presence of trace metals and nutrients in a soil (or soil amendment) as being readily available (generally soluble and easily taken up by plants or moveable through the soil); slowly available (requiring some combination of microbial or physical/chemical breakdown for release to the soil-water system); or relatively unavailable (requiring significant physical, chemical, and biochemical changes to become available for movement in the soil water and plant uptake). Most often, an element is present in the soil in all three relative states, transforming between the three states as soil chemistry and environmental conditions change over time. These processes are complex and quite variable in the soil environment and differ element by element. General terms used to describe these processes include transformation (change from one chemical form to another, often with different mobility, bioavailability, and toxicity), mobility (movement in the soil, generally with pore-water flow), and bioavailability (chemical form with respect to ability to be taken up by plant roots or soil macroorganisms or microorganisms). Soil mechanisms and processes that slow down or retard mobility and bioavailability are termed attenuation mechanisms. Phytotoxicity refers to compounds such as trace elements that are toxic to growing plants

## Major Elements and Plant Nutrients (Nitrogen and Phosphorus) in the Soil Environment

Major plant nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium are typically present in moderate amounts in biosolids; however, their total content, mobility in the soil environment, and bioavailability can vary widely. In addition, biosolids can contain low to moderate levels of soluble salts. Some generalizations can be made with respect to their fertilizer value and other issues with respect to plant nutrient management, mobility, and bioavailability.

Biosolids applied to soils provide nitrogen and phosphorus in several forms. Nitrogen may be present as organic nitrogen, ammonium, nitrate and nitrite ions. Figure D-3 presents the nitrogen cycle and shows how nitrogen moves through the environment. The transformation processes of nitrogen are biologically and chemically controlled and include biological fixation, mineralization, nitrification, and denitrification. With respect to nitrogen content, biosolids are comparable to barnyard manure, providing a source of low-grade but slow- to moderate-release nitrogen. Biosolids contain 1%-6% total nitrogen on a dry-weight basis (National Academy of Sciences 1996). Commercial fertilizers contain 11%-82% total nitrogen. Organic forms of nitrogen generally predominate in biosolids and must be converted to inorganic forms to be utilized by plants, in a process called mineralization. Organic forms of nitrogen are not available to plants. A smaller percentage of the total nitrogen is in the form of gaseous ammonia or dissolved ammonium. Biosolids also typically contain a moderate amount of total and dissolved (i.e., plant-available) phosphorus. As with other trace elements, the transformations between gaseous, soluble inorganic, and less soluble residual or organic forms, and associated mobility in the environment, are complex.




Source: California State Water Resources Control Board 1994.

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**Figure D-3**
**The Nitrogen Cycle**

The amount of organic and ammonia nitrogen in biosolids depends on the way biosolids are processed. Depending on site conditions, ammonium forms of nitrogen may be converted to ammonia gas and lost to the atmosphere, utilized by soil microorganisms, or converted to nitrates. Nitrate forms of nitrogen are the most biologically available but also the most mobile and present the greatest risk of groundwater contamination if released from biosolids at rates greater than the crops can uptake and utilize. Nitrates in biosolids are highly mobile in soil and have the potential to contaminate groundwater (Ocrtel 1995, Artiola and Pepper 1992) and are discussed in detail below.

**Mineralization of Organic Nitrogen.** Through mineralization, soil microorganisms convert organic forms of nitrogen to inorganic (mineral) forms—ammonium ($NH_4$) and nitrate ($NO_3$)—which are readily soluble in water and available for plant uptake. Nitrogen mineralization rates vary as a function of the organic nitrogen content of the biosolids, soil, and climatic conditions. Mineralization rates may also vary greatly for different sites, and mineralization rates need to be properly accounted for to determine agronomic rates of biosolids application. Nitrate is the dominant form in well-drained agricultural soils, whereas ammonium dominates where available nitrogen is at a premium and nitrification is low (University of Washington 1991). Mineralization of nitrogen can take from 1–5 years, depending on application rates and site conditions.

**Immobilization and Soil Nitrogen Storage.** Immobilization is the conversion of mineral forms of nitrogen to organic forms. Nitrogen can be stored in soil through binding to cation exchange sites, immobilization by soil micro-organisms, or as accumulated biomass. The ability to store nitrogen as ammonium on cation exchange sites is dependent upon the CEC level. Soil pH can also affect the CEC level: typically there are less exchange sites in more acidic soils. Biologic immobilization results in relatively long-term storage of nitrogen and generally occurs when the carbon to nitrogen ratio is greater than 30:1.

**Volatilization of Ammonia.** Ammonia and ammonium ions are added to the soil with biosolids or are produced during mineralization. Ammonia is a gas at normal temperatures and pressures, and the loss to the atmosphere can be great under certain conditions. Wind and temperature are major factors. Ammonia loss from biosolids or soils is also affected by pH. Under acidic conditions, nearly all of the ammonia is converted to the mineral form ammonium and the potential for gaseous loss is decreased. Above pH 7, more ammonia is present, increasing the potential for gaseous loss (University of Washington 1991). In acidic and neutral soils, $NH_3$ is converted to ammonium ions, which can then be sorbed by organic matter or clay particles, effectively taking it out of solution. The CEC level has been identified as one of the most important factors affecting ammonia volatilization (University of Washington 1991).

**Nitrification and Nitrogen-Phosphorus Relationships.** Nitrification is the microbiological transformation of ammonium ions to nitrate through a

two-step, biologically catalyzed transformation process involving the formation from nitrite, and then conversion to nitrate.

Phosphorus is typically present in biosolids in low to moderate amounts and also requires mineralization of organic forms to biologically available forms. The relative proportions of nitrogen and phosphorus are as important in plant nutrition management as total amounts. If nitrogen is limiting in the soil to plant growth (relative to phosphorus), then the relative excess of phosphorus may accumulate in the soil and be subject to erosion and leaching, potentially affecting surface water and groundwater. This usually is not a significant concern in most native California agricultural soils, which are generally deficient in both phosphorus and nitrogen. In most California soils, phosphorus is tied up in various chemical forms and is not lost from the soil, except the phosphorus that is attached to soil particles entrained by runoff.

More often the case with biosolids in California, application rates are dictated by the nitrogen content of the biosolids relative to crop needs, thereby raising concern that overapplication of nitrogen could result in excess leaching to groundwater and potential degradation of water quality. In some cases, particularly with lime-stabilized biosolids, the phosphorus present in the biosolids and available phosphorus present in the soil can be chemically bound to the lime (functionally making the phosphorus unavailable for plant uptake), or additional microbial growth in soils may assimilate the phosphorus to accomplish organic matter decomposition. Consequently, induced phosphorus deficiency in plants can result, causing reduced plant growth or affecting quality and yield. Similarly, biosolids high in carbon but relatively low in nitrogen (i.e., a high carbon:nitrogen ratio) can induce nitrogen deficiency as soil microorganisms have insufficient available soil nitrogen to decompose the organic matter in the biosolids. The former (carbon:nitrogen-induced deficiency) is apparently a rare phenomenon in California, but deficiency induced by poor nitrogen:phosphorus balance can occur in lime-stabilized biosolids. For example, stalks of oat grass (grown for hay) can grow disproportionately long in response to high nitrogen while seed set is reduced or delayed. This can cause bend-over ("lodging") of the grass stalks, making harvesting difficult and reducing yield and hay quality. If recognized early, such situations can be remedied by application of commercial fertilizers to bring the carbon:nitrogen or nitrogen: phosphorus ratio into balance with crop needs.

These problems usually can be easily avoided by testing the nitrogen, phosphorus, and potassium levels of the soil, measuring their concentrations in the biosolids, and adjusting biosolids additions and supplemental fertilizer applications to meet the agronomic needs of the crop. This involves setting application rates based on the nutrient most in abundance in the biosolids, not most limiting, and adding supplemental fertilizers when needed to make up for deficiencies.

The GO and Part 503 regulations currently require application at agronomic rates for nitrogen but do not provide guidance for phosphorus. As previously indicated, it is possible but rare in California to create phosphorus pollution problems from biosolids high

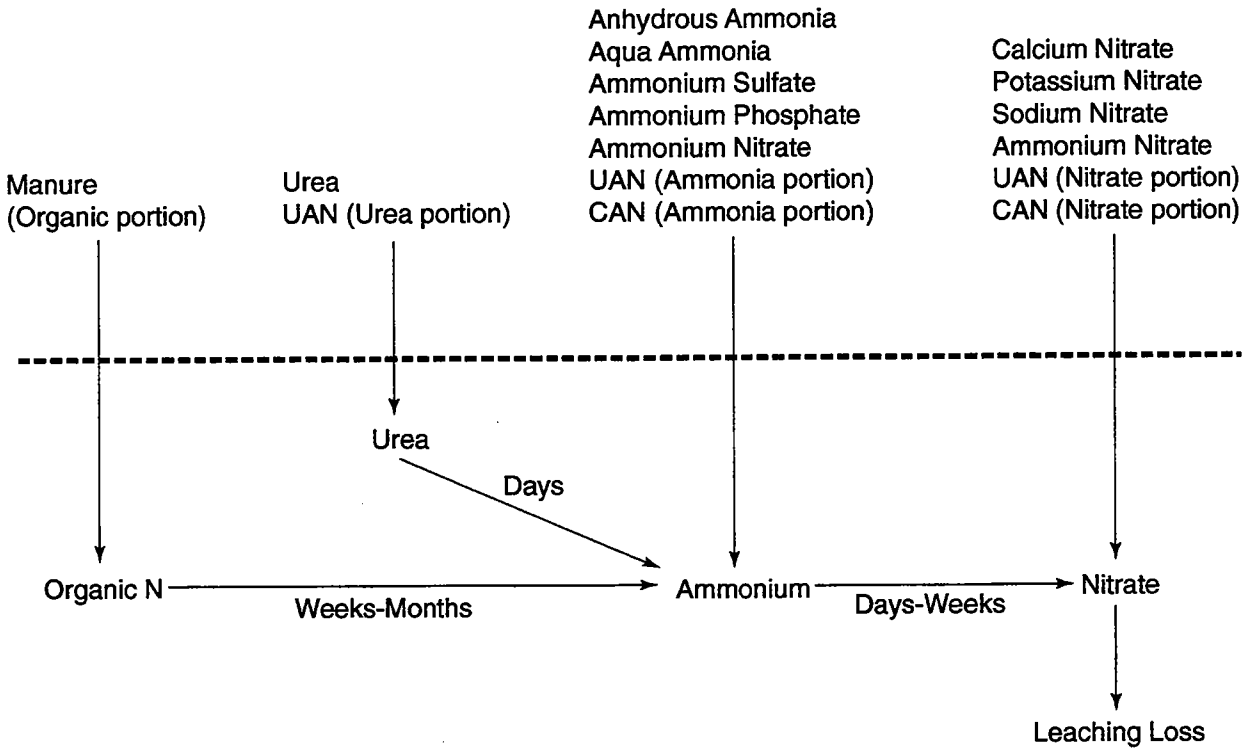
in phosphorus-to-nitrogen crop demand. It is also possible to create a nitrogen:phosphorus-induced deficiency problem in certain unusual conditions.

For non-exceptional quality biosolids, particularly from large municipal sources with heavy industry, annual biosolids application rates and the total long-term amount that can be land applied may be dictated by their trace element content, not by their nutrient load. This issue is discussed in the next section.

**Transport Mechanisms of Nitrates in Groundwater.** Nitrates are the form of nitrogen that presents a groundwater contamination risk. The biological and physical mechanisms that govern groundwater susceptibility to nitrate contamination are complex and highly variable. The three key processes that influence groundwater impairment from nitrates are related to 1) how the various forms of nitrogen contained in the biosolids react with the environment and are transformed to nitrate, 2) hydrologic features that transport nitrates through the soil to groundwater, and 3) how nitrates behave in the saturated portion of the aquifer and may reach municipal or domestic wells. Figure D-4 shows major fertilizer nitrogen sources and fertilizer nitrogen transformations in the soil (adapted from California Department of Food and Agriculture 1989).

The movement of nitrates from biosolids that are applied to the soil, through the unsaturated soil, to the nearest groundwater-bearing aquifer is governed primarily by the hydrology of the site and water infiltration. Nitrates are highly soluble and stable in most aqueous environments, making the dissolved fraction hard to remove from potential sources of drinking water. Both water and fertility management are necessary to prevent leaching of nitrates. Intentional overapplication of irrigation water is necessary to leach accumulated salts from the soil and maintain soil productivity. The total amount of nitrate leaching depends on the amount of nitrate dissolved in the soil-water profile and the volume of water percolating per unit time. The amount of nitrate is partially a function of the volume of nitrogen applied from all sources (fertilizer, manure, biosolids), and is thus subject to farm management practices.

Once out of the root zone, leachate containing nitrates will move into the unsaturated area above the water table. This unsaturated area is called the vadose zone (Figure D-3). The vadose zone may serve as a reservoir in which nitrates can accumulate. Further movement through the vadose zone is governed by complex flow and transport mechanisms. Travel time through the vadose zone may be many years (University of California 1995). Once the nitrates reach the saturated portion of the aquifer, they move with the prevailing groundwater flow. It is difficult to determine whether an observed level of nitrates in groundwater is a result of current or past operations. It is also difficult to quantify the level of nitrate contribution from the potential sources (agricultural, animal waste, septic, or wastewater sources) (California State Water Resources Control Board 1988, California Regional Water Quality Control Board 1994). Groundwater flow rates may vary greatly, and contaminated groundwater may take many years to reach municipal supply wells. The nitrate concentration in groundwater is influenced by freshwater recharge and dispersion, both of which may reduce contaminant




UAN - Urea Ammonium Nitrate
CAN - Calcium Ammonium Nitrate

Note: Time periods are for warm, moist soil.

Source: Adapted from California Department of Food and Agriculture 1989.

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**Figure D-4**
**Major Fertilizer Nitrogen Sources and Fertilizer Nitrogen Transformations in the Soil**

concentrations. Nitrates in groundwater do not impair agricultural beneficial uses of the water but may impair the suitability of the water for municipal and domestic uses. The assimilative capacity of a groundwater basin is a complex function of the recharge/discharge relationships and the mass loading of nitrogen from all sources.

**Biostimulatory Nutrients Transport to Surface and Groundwater.** Potential surface water quality impairment from biosolids applications are primarily related to potential runoff of biostimulatory substances that might impair the designated beneficial uses of water and result in violations of established water quality standards and objectives. Biostimulatory substances, primarily nitrogen and phosphorus, are typically found in low concentrations in aquatic systems. Eutrophication may result when additional nutrients are introduced into receiving waters. Eutrophication is the process by which nutrients increase biological productivity. Increased production can alter the biological system, potentially resulting in increased biomass production and resultant reductions in dissolved oxygen.

The effects of land application of liquid or dewatered biosolids on runoff water quality have received limited examination, in part because of the conservatism built into EPA's Part 503 guidelines, which require buffers and other management practices that restrict runoff and transport of potential contaminants (Northwest Biosolids Management Association 1998). Despite the limited amount of research specifically directed at liquid or dewatered biosolids applications, there are numerous studies evaluating nutrient runoff from agricultural lands, rangelands, and silvicultural areas where other biosolids or sources of nitrogen and phosphorus have been investigated. Nitrogen and phosphorus must be in mobile, dissolved forms for direct transport in surface water. Inorganic forms may be transported along with other sediments. There is a general consensus that application of biosolids or chemical fertilizer to no-till agricultural systems is a more effective means of limiting runoff of nutrients and sediment than application to conventional tillage (Breuggeman and Mostaghimi 1993, Mostaghimi et al. 1992, Northwest Biosolids Management Association 1998). Times of maximum seasonal precipitation have been strongly correlated to elevated nitrate levels in surface water and groundwater (Tindall 1994). Biosolids application techniques (surface application or incorporation into the soil, till or no till), total application rates, seasonal weather patterns, ambient soil moisture, and the duration and intensity of rainfall all influence the potential for runoff to mobilize nutrients in biosolids (Northwest Biosolids Management Association 1998).

Liquid biosolids have far greater concentrations of the mobile mineral forms of N and P than do the dewatered biosolids which are regulated by the GO. Studies related to the application of liquid biosolids to a watershed have demonstrated that there was little to no impact on stream water quality with respect to N and P levels. It is suggested that the application of dewatered biosolids will likely have no significant impact on the quality of water emanating from watersheds where dewatered biosolids are applied. This statement is qualified by the fact that there is a lack of peer-reviewed studies on the

subject of water quality runoff covering an extensive range of conditions under which biosolids might be applied (Northwest Biosolids Management Association 1998).

Phosphorus is present in both organic and inorganic forms in biosolids, typically at concentrations of 0.8%–6.1%. Inorganic forms of phosphorus are quite insoluble and phosphorus tends to concentrate in the organic and inorganic solid phases. The amount of phosphorus applied is more than sufficient to meet the needs of the crop in areas where biosolids are applied to meet nitrogen requirements. At the appropriate application rate for nitrogen, available phosphorus may exceed the levels needed for crop production. High levels could increase the risk of surface water contamination if runoff is allowed. Based on long-term evaluations of treated biosolids over periods ranging from 9 to 23 years, the Water Environment Federation (1994) has recommended that soil phosphorus levels be monitored in areas where biosolids applications are used continuously over time, and that biosolids application rates may need to be determined by crop phosphorus levels rather than to meet the nitrogen needs of crops (National Academy of Sciences 1996).

Other essential plant nutrients and inorganic constituents are found in biosolids, including calcium, iron, magnesium, manganese, potassium, sodium, and zinc. Where biosolids are applied according to agronomic rates for nitrogen, most of these essential nutrients are usually present in amounts adequate to meet the needs of the crop (National Academy of Sciences 1996). No studies were found that indicated problems with excess runoff or leaching of other inorganic constituents found in biosolids. The concentration of other salts or minerals that could increase the total dissolved solids concentration in runoff or leachate has not been identified as a problem for contaminant runoff or leaching to groundwater. This is because most of the dissolved minerals are leached from the biosolids during wastewater treatment and sludge dewatering operations.

## Trace Elements and Heavy Metals

### Trace Elements and Heavy Metals in the Soil Environment.

The terms *trace metal* and *trace element* refer to chemical elements normally present in the environment in very low concentrations. Typically, elements that are present in the soil in the dissolved phase at concentrations less than 0.01 microgram per milliliter are considered to be trace elements. Major elements or plant nutrients usually are present in the soil solution phase at concentrations orders of magnitude higher. Heavy metals are defined as trace elements that have densities greater than 5.0 milligrams per cubic centimeter.

In small quantities, many elements are essential to plant growth. These include fluoride, silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, silicon, selenium, molybdenum, tin, and boron. At higher concentrations, some of these elements may become toxic to plants or accumulate in plants at levels that are toxic to animals that feed on them. In some cases, the range in concentrations between deficiency and toxicity is narrow, such as with boron. In several cases, there is no known biological

necessity for a trace metal and its occurrence in small quantities in the soil solution may be harmful to plants. Lead, cadmium, and arsenic are examples of this effect. In other instances, such as with molybdenum, there is little or no plant toxicity at elevated soil levels, but grazing animals can be adversely affected by high levels in plant forage. Plants can vary widely in their sensitivity to trace element concentrations in the deficiency or toxicity range, in their capability to take up trace elements, and in their ability to avoid uptake even at high soil solution concentrations. Some, but not all, of the trace elements that can be present in biosolids in elevated concentrations are regulated in EPA's Part 503 regulations.

Trace metals may behave differently compared to more common soluble salts and plant nutrients in soils. Unlike soluble salts, most metallic compounds are not readily soluble in water or very mobile in the soil, except at low pH levels (as in strongly acidic soils). Because of their affinity to soil particles, including clay and organic colloids, carbonates, and iron complexes, trace metals are often retained in the soil and normally do not move readily with soil water. Therefore, most metals added to soils from irrigation water, reclaimed water, fertilizers, or organic additions such as biosolids may readily accumulate in surface layers and remain there, relatively biologically unavailable and immobile.

There are, however, important exceptions to this: arsenic, molybdenum, and cadmium in particular can be mobile in non-acidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic in low soil-solution concentrations. Boron behaves differently in the soil than other trace elements, in that it is somewhat soluble and mobile. Plants vary widely in their boron phytotoxicity. Boron is naturally present in excessive concentrations in a small proportion of California soils. Although the total metal concentration is easy to measure in soils and biosolids, it is often a poor indicator of the mobility or bioavailable quantity of the metal in the soil when an understanding is lacking of the chemistry of the particular soil to which biosolids containing metals have been added.

The amount of accumulation of metals in soil (soil loading) is a function of the concentration of metals in the irrigation water, reclaimed water or biosolids, and the amount of material applied. The multiplication of concentration times annual application rate is termed the annual loading rate; cumulative loading refers to summation of loading over time. These are usually given in terms of pounds of trace metals added per acre or, in metric terms, kilograms per hectare. It is important to note that loading refers to the total amount added to the soil in all forms, and not the final soil concentration.

Total loading rates also do not distinguish between plant-available and mobile forms of metals in the soil solution. Aside from those originating from cities with extensive heavy industry, most biosolids contain low concentrations of trace metals, relative to levels that can accumulate and adversely affect soil productivity and agricultural sustainability under normal California soil conditions and loading rates. The low mobility of biosolids derived metals in typical soil environments has been demonstrated in research conducted by Camobreco et al. (1996) and Dowdy et al. (1991). However, some scientists remain

cautious regarding the potential for adverse soil quality and health effects from poorly designed and poorly managed biosolids land application programs, particularly for non-exceptional quality biosolids or where unusual soil conditions and cropping patterns occur (Cornell Waste Management Institute 1999). The current GO and Part 503 regulations do not require specific consideration of bioavailable metals concentrations, irrigation and cropping practices that can affect bioavailability, or bioaccumulation factors and mobility when determining biosolids application rates.

Movement of water containing soluble trace elements and nutrients through the soil, and hence bioavailability, is influenced by a variety of physical processes and chemical reactions that determine the capacity of a natural soil body to immobilize metals, nutrients, and trace elements. The mechanisms of removal and movement are complex and depend on both the source and characteristics of the trace elements, the physical and chemical properties of the soil, and the rate of water movement through the soil.

Crops may also vary widely in their ability to uptake and bioaccumulate trace elements and in their sensitivity to concentrations in deficiency or phytotoxicity ranges. At any time, the concentrations of the major elements and trace metals in the solution phase of the soil-water-plant system are governed by various reactions, such as acid-base equilibria, complexation with organic and inorganic lignins and organic factions forming chelated compounds, precipitation and dissolution of solids of oxides and carbonates, and ion-exchange-adsorption on clay minerals. The issue is so complex that entire textbooks are written on the environmental chemistry of soils and the transformation and movement of organic and inorganic compounds in soils (for example, see McBride 1984, Dragun 1988, Davies 1980, Kabata-Pendias 1984).

The concentrations of major and minor elements in the soil-water solution are controlled by the progression in equilibrium in the solid and solution phases between unavailable and readily bioavailable forms, the rate at which these reactions occur, the rate of biological uptake by plants, and the loss from the system by groundwater flow. Soil clay content, CEC, organic matter content, oxidation/reduction state, and pH all influence the mobility and bioavailability of metals/nutrients in the soil to some degree.

The solubility (and hence mobility and bioavailability) of cadmium, copper, nickel, zinc, and chromium compounds is significantly pH dependent. The solubility of these metals typically increases as pH levels decline (i.e., become more acidic). These metals are associated with iron and manganese hydrous oxide compounds whose solubility increases with decreasing soil pH. The hydrous oxide or sulfide compounds are also more soluble under reducing conditions (i.e., when losing electrons caused by prolonged anaerobic conditions). As a result, poorly drained, acidic conditions that occur in some California soils tend to favor mobilization of metals, whereas well drained, non-sandy, basic (alkaline) to slightly acidic soils tend to immobilize most cationic metals. Lead generally has limited mobility in the soil. In slightly acidic, non-calcareous soils, lead generally is not bioavailable and tends to precipitate as lead hydroxides or lead polymorphites; consequently, it does not readily reach groundwater. Maintaining suitable soil pH levels,

drainage, and organic matter content thus becomes extremely important in managing lands to which biosolids have been applied. Because metal mobility varies with pH and the particular metal species, it is important to characterize and understand biosolids, soil chemistry, soil hydrology, and crop conditions to ensure sound biosolids application management.

The amount of finely divided, stable organic matter (humic and fulvic acids) in the soil can also greatly affect the mobility of metals in the soils by forming insoluble or slightly soluble complexes. Biosolids provide a rich source of these substances. Other reactions that immobilize metals include adsorption onto clay surfaces and ion exchange, particularly of divalent metallic cations. The organic matter- and clay-rich valley bottom land, basin, and low terrace soils in many areas of California should strongly immobilize metals contained in biosolids through organic complexing and cation exchange. Of greater concern is sandy, acidic soils with low organic matter content, in which metals are easily transformed to be readily bioavailable and in which water moves freely with little soil interaction. These soil conditions are somewhat rare in California, but they occur on recent sandy alluvial fan soils associated with the granitic foothills of the southern San Joaquin Valley, in some high mountain valleys, and in parts of San Diego and Monterey Counties. The soils of valley margin foothills, which are often acidic and have low organic matter content, can also be difficult to manage for biosolids application. Areas of shallow perched groundwater may also raise management concerns.

Because of the complexity of all the possible interactions of nutrients and trace elements in the soil-water-plant system, it is difficult to accurately predict element concentrations in plants from a biosolids source as it leaches through the root zone, is taken up by plants, and/or moves through the shallow groundwater system. This difficulty is compounded when water movement through the soil and subsequent deep percolation to groundwater or to streams must also be considered. Although scientists have developed several numerical models that can quantitatively estimate movement of major nutrients and some metals in the soil-water solution, plant uptake, and discharge to shallow groundwater, these are approximations at best. Quantitative analysis of particular metal types requires consideration of site-specific characteristics of soils, water movement, climate, and crop type. Given the wide range of these conditions in California, the use of numerical models is not practical for the purposes of this EIR. Broad assumptions of soil-crop factors were used in evaluating potential plant uptake of metals and in formulating the Part 503 sludge regulations, some of which have been questioned (Cornell Waste Management Institute 1999).

Table D-6 provides general information on the characteristics of major and trace elements, including factors influencing bioavailability and plant toxicity or phytotoxicity. Table D-7 shows various physical and chemical processes in the soil that have important effects on the mobility and bioavailability of metals. Included in the table are mean $K_d$ values (a measure of the mobility or adsorption propensity of the metal while moving with groundwater through porous media) determined for typical soils for various elements, and

# Table D-6
# Occurrence, Biological Function and Toxicity of Trace Metals in Soils

| Trace Metal | Common Range in California Bio Solids[a] (*mg/kg*) | Common Range in Soils[b] (*Total mg/kg*) | A Typical Soil Concentration[c] (*Total mg/kg*) | Biological Function[d] | Mammalian Toxicity[d] | Phytotoxicity[d] | Impact on Crop[e] (*mg/kg*) | Cumulative Pollutant Loading Rate Limits (*kg/ha*)[f] | Title 22 Toxic Limits[g] (*mg/kg*) |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | | 0.1 - 40<br>3.6 - 8.8 | 6 | None known in animals. Constituent of phospholipid in algae and fungi | High | Medium-High (5-20) | Not a required element for plant growth | 41 | 500 |
| Boron | | 2 - 55 | 10 | Essential to plant. Phosphogluconate | Low | Medium-High (50-200) | Required, wide species differences | Not regulated | Not listed |
| Cadmium | | 0.01 - 1.1 | 0.06 | None known | High Cumulative poison | Medium-High (5-30) | Not required, toxic to plants | 39 | 100 |
| Chromium | | 20 - 85 | 40 | May be involved in sugar metabolism in mammals | High ($Cr^{6+}$)<br>Medium ($Cr^{3+}$) | Medium-High (20-100) | Not required, low plant toxicity | Not regulated | 2,500 |
| Copper | | 14 - 29 | 20 | Essential to all organisms, cofactor in redox enzymes, $0_2$ transport pigments | Medium | Medium (30-300) | Required 2-4 mg/kg; toxic>20 mg/kg in plant tissue | 1,500 | 2,500 |
| Lead | | 0.2 - 200 | 10 | None Known | High Cumulative poison | High (1-3) | Low plant toxicity | 300 | 500 |

## Table D-6. Continued

| Trace Metal | Common Range in California Bio Solids[a] (*mg/kg*) | Common Range in Soils[b] (*Total mg/kg*) | A Typical Soil Concentration[c] (*Total mg/kg*) | Biological Function[d] | Mammalian Toxicity[d] | Phytotoxicity[d] | Impact on Crop[e] (*mg/kg*) | Cumulative Pollutant Loading Rate Limits (*kg/ha*)[f] | Title 22 Toxic Limits[g] (*mg/kg*) |
|---|---|---|---|---|---|---|---|---|---|
| Mercury | | 0.01 - 0.08 | -- | None Known | High (soluble or volatile forms). Cumulative poison | Medium (10-50) | High plant toxicity | 17 | 20 |
| Molybdenum | | 0.35 - 5.8 | 2 | Essential to all organisms, enzyme cofactor in $N^2$ fixation, $NO_3$ reduction | Medium | Medium-High (10-100) Bio-accumulative | Required; at <0.1 mg/kg in plant tissue | Not regulated | 3,500 |
| Nickel | | 10 - 1,000 | 40 | None known in mammals. May be essential to plants. Found in urease enzyme | Medium | Medium-High (5-30) Bio-accumulative | Not required toxic >50 mg/kg in plant tissue | 420 | 2,000 |
| Selenium | | 0.19 - 1.05 | 0.5 | Essential to mammals and some plants | High | High (5-10) | Toxic >50 mg/kg | 100 | 100 |
| Silver | | 0.1-5.0 | -- | None known | High | Low-Medium (100-400) | -- | Not regulated | 500 |
| Zinc | | 10-300 | 50 | Essential to all organisms. Cofactor in numerous enzymes | Low-Medium | | Required: toxic >200 mg/kg in plant tissue | 2,800 | 5,000 |

Sources:

[a]

[b] Compiled from McBride 1994, Drugan 1988, Pettygrove 1984.

[C] Pettygrove et al July 1984.

[D] Abstracted from McBride 1994

[e] Abstracted from McBride 1994.

[f] EPA 503 Rules.

[g] California Title 22 Limits.

# Table D-7
# Trace Element Mobility and Soil Transformation Mechanisms

| Trace Element | Mean $K_{ds}$ | Mobility at Various Soil pH Levels | | | Reacts to Less Bio-Available Form With | | | Primary Attenuation Mechanism |
|---|---|---|---|---|---|---|---|---|
| | | Strongly Acid pH <5.5 | Moderately Acid pH 5.5 to 7.0 | Alkaline pH >7.0 | Fe/Mn Oxides | Organic Matter | Other | |
| Arsenic | 1.2 | Medium-Low | Medium | Medium-High | Yes | -- | sulfide, clays | precipitation (iron), specific adsorption |
| Boron | -- | Medium-Low | High | Medium-High | -- | -- | calcium | caborate precipitation |
| Cadmium | 1.9 | Medium | Medium-High | Medium | No | -- | reducing conditions | precipitation (hydroxides, carbonates, sulfides), specific adsorption |
| Chromium | 7.7 | Very Low | Very Low | Very Low | Yes | -- | -- | precipitation |
| Copper | 3.1 | High | Medium to Low | Very Low | Yes | Yes | sulfide, sulfate clay adsorption, carbonate, phosphate, reducing conditions | precipitation (hydroxides, carbonates, sulfides), specific adsorption |
| Lead | 4.6 | Low | Low | Low | -- | -- | reducing conditions | precipitation (hydroxides, carbonates, sulfides), specific adsorption |
| Mercury | -- | Medium | Low | Low | Yes | -- | sulfide, reduced conditions | adsorption at high pH |
| Molybden um | -- | Low | Medium-High | High | Yes | Yes | n____erystalime aluminosilicates | clays at low pH |
| Nickel | -- | High | Medium to Low | Very Low | Yes | Yes | sulfide adsorption, silicate minerals | precipitation (hydroxides, carbonates, sulfides), |

## Table D-7. Continued

| Trace Element | Mean $K_{ds}$ | Mobility at Various Soil pH Levels | | | Reacts to Less Bio-Available Form With | | | Primary Attenuation Mechanism |
|---|---|---|---|---|---|---|---|---|
| | | Strongly Acid pH <5.5 | Moderately Acid pH 5.5 to 7.0 | Alkaline pH >7.0 | Fe/Mn Oxides | Organic Matter | Other | |
| Selenium | 1.0 | High | High | High to High | Yes | Yes | reducing conditions, absorption | precipitation (iron), specific adsorption |
| Silver | 4.7 | High | Medium to Low | Very Low | Yes | Yes | reducing conditions, sulfide | cation exchange |
| Zinc | 2.8 | High | High to Medium | Low to Very Low | Yes | Yes | sulfide, precipitation by carbonate | precipitation (hydroxides, carbonates, sulfides), specific adsorption |

Sources: Dragun 1998, McBride 1994, Baes and Sharp 1983, Kabate-Pendias 1992, and Selim and Amacher 1997.

Note: $K_{ds}$ is a coefficient or measure of the mobility or adsorption propensity of a metal while moving with water through porous media, such as a soil.

conducted for only those trace metals that were identified as having potential to be present in biosolids at sufficient concentrations to cause environmental toxicity or other impairment. Of the original list of approximately 200 pollutants evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water and groundwater pathways were conducted for seven trace metals (U.S. Environmental Protection Agency 1992). All other trace metals were either not detected in the sewage sludges tested during the 1990 National Sewage Sludge Survey (U.S. Environmental Protection Agency 1990) or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations, neither the surface water or the groundwater pathway was found to be limiting to trace metal concentration limits or cumulative loading rates for land application of biosolids.

Some of the factors and assumptions used during the Part 503 development process for setting limits on trace metals are controversial. The risk assessments conducted for the groundwater pathway are a source of controversy among researchers and respondents to the scoping notice for this EIR. The primary arguments for considering inclusion of limits to organic compounds in the Part 503 regulations include the following: (1) elimination process was arbitrary, (2) lack of monitoring requirements results in not having information on which to base application decisions, (3) may not consider risks associated with specific compounds that lack supporting research data, and (4) groundwater dilution factors may have been too large (Cornell Waste Management Institute 1999).

Based on the recent 1998 California Association of Sanitary Agencies (CASA) survey of trace metal concentrations in sewage sludges from California (California Association of Sanitation Agencies 1999), average concentrations and variability are lower than the 1990 National Sewage Sludge Survey (NSSS) data (U.S. Environmental Protection Agency 1990). Average concentrations of cadmium, copper, lead, nickel, and zinc for the 1998 CASA data range from 25% to 50% of the 1990 national averages; 1998 CASA averages for arsenic, mercury, and molybdenum are generally similar to the national estimates. Selenium is the only trace metal that has higher average concentrations in the 1998 CASA data than in the 1990 NSSS results. Maximum reported concentrations of copper, mercury, and selenium are the only measurements in the 1998 CASA survey data that exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation.

## Synthetic Organic Compounds

**Synthetic Organic Compounds in the Soil Environment.** Many SOCs used in industrial, commercial, and household applications can be conveyed to wastewater treatment plants through the municipal wastewater collection and treatment process, and therefore they can be present in biosolids. As with nutrients and trace elements, the character of the biosolids with respect to SOC content is a function of the type of business and industry within the wastewater treatment service area, any onsite pretreatment conditions, and the effectiveness of the wastewater treatment process.

Many organic compounds either are volatile (and are lost during the treatment process) or readily biodegrade in the treatment process, which is designed and managed to foster microbial decomposition. Other volatile compounds are quickly lost to the atmosphere following biosolids incorporation in the soil. Because of this, the possible presence of volatile organic compounds in biosolids has generally not been of great concern to regulators and the environmental community.

However, other non-volatile or semi-volatile organic compounds (SVOCs) generally occur in low amounts in municipal biosolids. These include plastic-like compounds (phthalates), pesticides, phenols, detergent additives, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyl compounds (PCBs), and the group of chlorinated dibenzo-para-dioxin and chlorinated dibenzo-furan compounds that are often cumulatively referred to as dioxins. Currently, the Part 503 regulations do not contain minimum standards or require testing of biosolids for SOCs; however, the proposed GO monitoring program would require testing of biosolids for PCBs and SVOCs. Upper limits are set by state and federal general hazardous materials rules and regulations, with control relying on local municipalities enforcing source inspection and pretreatment provisions associated with their wastewater discharge permits. Toxic chemicals such as DDT, chlordane, aldrin, dieldrin, benzo(e)pyrene, and lindane are known to cause cancer, and other compounds are known to be teratogenic (e.g., dioxin, 2,4,5-trichlorphenol, and pentachlorophenol). Consequently, many of the SOCs have been prohibited from use or manufacture in the United States.

Much less is known about SOCs with respect to soil accumulation, plant uptake, and concentration mechanisms in soils than is known about trace elements. The knowledge base is much greater with regard to the attenuation, degradation, and mobility of volatile compounds, pesticides, and PAHs in the soil. It is generally understood that the primary exposure pathways for organic compounds are through migration to drinking water sources or as residues and soil dust that accumulate on plant leaves, rather than as direct plant uptake. Direct ingestion of soil containing biosolids or ingestion by grazing animals as dust on plant parts is another area of concern. There are human health risk factors; however, as with phytotoxic trace elements, accumulation of SOCs in soils at levels that make the soils unusable for crop or livestock production can be considered a rather drastic agricultural soil productivity impact. This issue is reviewed in Chapter 4, “Land Productivity”.

### Synthetic Organic Compounds in the Aquatic Environment.

Biosolids can contain various organic compounds that are removed from the liquid waste stream during the wastewater treatment process. More than 100 EPA-designated priority pollutant organic compounds are regulated through various federal and state drinking water standards, ambient surface water quality criteria, and hazardous waste laws. Most of the priority pollutant organic compounds are generally not detected in biosolids or are present at very low levels (U.S. Environmental Protection Agency 1990).

It is generally recognized that transport of organic compounds from the solid to the liquid phase in the soil environment is limited for most constituents (U.S. Environmental Protection Agency 1992, Chaney 1990). Demirjian et al. (1987) evaluated the fate of organic compounds in soil from biosolids application and showed that organic compounds were degraded in the soil or adsorbed in the surface layer. At an application rate of 100 tons per acre, most compounds degraded considerably during one irrigation season. At less than 25 tons per acre, most compounds degraded to less than 50% of initial concentration. The authors concluded that their experiment represented severe conditions for land application because of the sandy soils and heavy irrigation requirement and, therefore, nutrients and heavy metals would be the limiting factors in determination of application rate under average soil conditions. Alexander (1995) showed that the binding effect that "locks" toxins in the soil becomes more pronounced the longer the pollutant remains in soil. The higher the organic matter, the greater the binding effect. The report indicates that disappearance of appreciable amounts of insecticides from the field was not a result of leaching because all are extensively sorbed and little vertical movement has been detected, even after many years. If a chemical persists and remains in contact with particulate matter for some time, it becomes increasingly resistant to extraction by many solvents. Rappe et al. (1997) reported that dioxins have extremely low solubility and are unlikely to leach from soil to groundwater.

**Part 503 Risk Assessments of Synthetic Organic Compounds for Surface Water and Groundwater Pathways.** Toxic organic compounds were included in the original pollutant screening and risk assessments conducted during development of the Part 503 regulations for land application of biosolids. Of the original list of approximately 200 pollutants evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water (Pathway #12) and groundwater (Pathway #14) were conducted for 10 priority pollutant organic compounds (U.S. Environmental Protection Agency 1992). All other organic compounds were not detected in the tested sewage sludges or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations, the groundwater pathway was not found to be limiting for the concentration limits or cumulative loading rates of any organic compounds resulting from land application of biosolids. The surface water pathway of humans eating fish that accumulate pollutants in surface runoff was the limiting pathway for setting limits on DDT/DDE compounds.

Upon completion of the EPA risk assessments for organic compounds, EPA concluded that regulations for organic compounds were not required for the final Part 503 regulations because they met at least one of the following criteria: (1) the pollutant was banned from use, has restricted uses, or is not manufactured in the United States; (2) it was detected in less than 5% of the sludges tested for the 1990 National Sewage Sludge Survey; or (3) the 1-in-10,000 cancer risk limit was less than the 99% maximum probable concentration based on 1990 NSSS data. Limits were not set for DDT/DDE compounds because they are excluded from all of EPA's screening criteria. Several organic compounds were deferred for future consideration and evaluation for round two of the

rule development, when more data would be available. The organic compounds of interest for future consideration included PCBs and dioxin. There is also research being conducted on various other aromatic surfactants (e.g., linear alkylbenzene sulphonates and ethoxylates) that may have hormone-mimicking properties; however, very little is known about their role in transport from biosolids application sites (Krogman 1997, Clapp et al. 1994).

Some of the factors and assumptions used during the Part 503 development process for setting limits on toxic organic compounds are controversial. The elimination and deferment of Part 503 limits for organic compounds is a source of controversy among researchers and respondents to the scoping notice for this EIR. The primary arguments for considering inclusion of limits to organic compounds in the Part 503 regulations were identified above (see "Part 503 Risk Assessments of Trace Metals for Surface and Groundwater Pathways"). Comments received during the scoping process indicated a concern that the Part 503 risk assessments may not accurately reflect environmental conditions specific to California or account for risks from new organic compounds such as pharmaceuticals. There is also general concern regarding the potential oversight of the Part 503 regulations in not accounting for synergistic or combined risks from exposure to multiple constituents that may be present in biosolids. EPA contends that the risk assessment process was based on conservative assumptions and no scientific data are present that would invalidate the results of the risk assessments (U.S. Environmental Protection Agency 1995).

# Regulatory Setting

## Key Policies, Laws, Programs

### Water Quality Regulations and Permits.

Numerous laws, ordinances, and guidelines are administered by local, state, and federal agencies to limit the discharge of pollutants to the environment; maintain surface water and groundwater quality at existing levels; and protect beneficial uses such as municipal, industrial, and agricultural water supply, recreation, and fish and wildlife habitat. The California State Water Resources Control Board (SWRCB) establishes water quality control policies in California in accordance with the Porter-Cologne Water Quality Control Act and the federal Clean Water Act and implements those policies through nine individual RWQCB offices. Federal, state, and local water quality regulations are applicable to any chemical constituent contained in biosolids or any activities that would occur as a result of land application of biosolids. The nine regions were initially established according to regions with similar and unique hydrologic and water quality characteristics. Figure 1-1 shows the names and boundaries of the nine regional boards.

Each RWQCB has primary responsibility for designating the beneficial uses of water bodies within the regions, establishing water quality objectives for protection of those uses, and issuing permits and conducting enforcement activities. Beneficial uses are those uses of the water resource for which numerical and narrative water quality objectives are established to prevent water quality impairment. Water quality objectives and associated narrative and numerical water quality objectives are established in a Basin Plan for each region that is updated through a triennial review process. The principal permitting processes administered by the RWQCBs for water quality protection include issuance of waste discharge requirements (WDRs) for discharge of waste to land and water, and permits for the National Pollutant Discharge Elimination System (NPDES) in accordance with the federal Clean Water Act. WDRs and NPDES permits issued to waste dischargers impose discharge restrictions and pollutant limits, that take into consideration applicable state and federal water quality criteria for surface water, groundwater, and drinking water. The permit processes must also consider the state anti-degradation policy that is intended to maintain high quality waters by setting criteria that must be met before a discharge is allowed that would reduce water quality and yet still maintain beneficial uses.

**Numerical Water Quality Criteria.** Potential effects of waste discharges may be evaluated, undergo regulatory review by other resource agencies, or have permits issued that are based on a several categories of state and federal water quality criteria. Applicable water quality criteria include Basin Plan water quality objectives for surface water and groundwater, state and federal ambient surface water quality criteria, and state and federal drinking water standards. The RWQCBs are required to include effluent limitations on toxic priority pollutants in WDRs and NPDES permits issued for wastewater discharges to surface waters when the discharge may cause the surface water to exceed established priority pollutant standards. The regulated priority pollutants include approximately 130 trace metal and organic compounds that are known to be toxic to living organisms when present in water at sufficient concentrations.

Regulations pertaining to priority pollutants have been developed over the years in four main regulations, including narrative requirements in the Clean Water Act, the National Toxics Rule (NTR), the now-defunct Inland Surface Waters Plan/Enclosed Bays and Estuaries Plan (ISWP/EBEP), and the recently proposed California Toxics Rule (CTR). The proposed CTR was developed in accordance with Section 303(c)(2)(B) of the Clean Water Act (Federal Register Vol. 62, No. 150 - August 5, 1997) to fill the gap in regulation created by the legal overturn of the ISWP. The SWRCB subsequently issued a Draft Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California and Accompanying Functional Equivalent Document (California State Water Resources Control Board 1997) that identifies the proposed rules for implementation of the CTR criteria as a new ISWP. Following adoption of the CTR and/or another form of ISWP, wastewater discharges and NPDES-permitted facilities will be required to comply with the new standards for priority pollutants. The criteria were developed to protect against acute and chronic toxicity of

aquatic organisms and humans from ingestion of water or organisms in contact with the water. By definition, the criteria represent "the highest concentration of a substance in water which does not present a significant risk to the aquatic organisms in the water and their uses". Under the criteria, toxicity in aquatic organisms is defined as mortality or reduction in growth; toxicity in humans is defined as an increased risk of disease or cancer. The criteria also provide protection from bioaccumulation in aquatic organisms. Bioaccumulation is a process whereby, through absorption or ingestion, the constituents accumulate in the tissues of aquatic plants or animals over time.

Drinking water standards, established by the DHS under Title 22, Division 4, Chapter 15 - Domestic Water Quality and Monitoring, are applicable to groundwater and surface water. EPA develops similar standards under the federal Safe Drinking Water Act. Both sets of laws contain MCLs that are based on a 1-in-1-million ($10^{-6}$) incremental risk of cancer from ingestion of carcinogenic compounds and threshold toxicity levels for noncarcinogens. The MCLs are also based on technological and economic factors of the feasibility of achieving and monitoring for the pollutants in a drinking water supply. Secondary MCLs are established for welfare considerations such as taste and odor control and laundry staining. The MCLs apply to the quality of the water after it has entered a distribution system and do not apply to the quality of the untreated source water. The standards apply to the source water only when specifically established in the basin plan by the RWQCB.

### National Pollutant Discharge Elimination System Permits.

Wastewater treatment plants (WWTPs) that discharge to surface waters are regulated through the NPDES permitting process, which is mandated under the Clean Water Act (Code of Federal Regulations [CFR], Title 40). The NPDES permit system is divided into separate programs and regulations for point-source discharges, such as industrial facilities and WWTPs, and nonpoint sources such as urban stormwater runoff from larger municipalities and storm water runoff from general construction and industrial activities. The NPDES permit process for WWTPs typically involves the imposition of standards on the effluent and receiving water body for various chemical, physical, and biological parameters (e.g., flow, temperature, pH, biochemical oxygen demand [BOD], dissolved oxygen [DO], total coliform bacteria, suspended and settleable matter, turbidity, residual chlorine, ammonia, or other compounds of specific concern for a given receiving water). NPDES permits focus mainly on the liquid discharge, whereas WDRs focus on the solids generated at the facility. However, biosolids treatment and disposal regulations can be included in the NPDES permit for the treatment plant or can be covered under separate WDRs that are also issued by the RWQCB.

### NPDES Pretreatment Program for Industrial Discharges.

Pretreatment of industrial discharges is mandated by the Clean Water Act of 1977 (33 USC Sections 1251-1376; P.L. No. 95-217, 91 Stat. 1566). EPA has established pretreatment standards (see 40 CFR Part 403) for various industrial categories. EPA created the National Pretreatment Program and first issued pretreatment regulations in November 1973. Following amendment of the Clean Water Act, the regulations were

revised in June 1978 and again in January 1981. The purpose of the National Pretreatment Program is to regulate the discharge of toxic pollutants or unusually large amounts of conventional pollutants (e.g., BOD and total suspended solids [TSS]) to municipal sanitary sewers and the associated wastewater treatment plants. Toxic pollutants can include a large variety of potential compounds but generally refer to the EPA priority pollutant trace metal and organic compounds, other volatile organic compounds and SVOCs, pesticides, and chlorinated organic compounds. The goal is to protect receiving water quality and the environment from the effects of these discharges because of their potential to "pass through" or receive only partial or no treatment by the wastewater treatment plant.

An individual pretreatment program typically consists of: (1) identification of pollutants that could cause upset or bypass (pollutants of concern); (2) development of discharge limitations for nondomestic discharges (local limits); (3) identification of nondomestic discharge sources; and (4) implementation of nondomestic monitoring program to enforce the local limits. Local limits may include both narrative and numeric limits. Narrative limits are general statements of prohibitions or restrictions of a particular discharge, while numeric local limits are maximum allowable concentrations that are calculated for each pollutant of concern that a facility discharge to the sewer cannot exceed. Numeric local limits are calculated from the most limiting criteria or standard that could upset the wastewater treatment process or pass through in the effluent. The criteria and standards used for the local limit calculations include the applicable state and federal water quality criteria described above. Local agencies develop, and seek EPA approval of, their industrial pretreatment programs through local sewer-use ordinances.

Narrative and numeric limits used in source control programs have effectively reduced the pollutant concentrations entering the facility. A fraction of the pollutants are removed from the wastewater that is treated at the facility. Because most toxic trace metal and organic compounds are not destroyed during the wastewater treatment process, most of the fraction removed from the wastewater end up in the biosolids generated at the facility. Removal rates of trace metals and organic compounds are fairly constant at treatment facilities; therefore, lower influent pollutant concentrations results in lower biosolids pollutant concentrations. Source control programs have significantly reduced the biosolids pollutant concentrations. This is shown by the decrease in biosolids pollutant concentration at facilities with aggressive source control programs. As source control programs are continually being improved because of more stringent pollutant limitations, pollutant concentrations in biosolids will continue to decrease or, at a minimum, remain the same in the future.

## Nonpoint Source Assessment and Watershed Initiative

In 1988 the SWRCB prepared the "Nonpoint Source Assessment Report" (California State Water Resources Control Board 1988) documenting water quality threats from these sources and evaluating programs designed to reduce this contaminant threat.

Nutrients, sedimentation, and other agriculture chemicals are acknowledge as having contributed to groundwater and surface water impairment. Unlike point sources of contamination which are discreet and subject to regulatory control, nonpoint sources (NPS) of contamination are typically associated with long standing and generally acceptable societal practices and land use activities where liability for contamination is hard to determine, and where regulatory programs cannot easily remedy the problem. Agriculture, silviculture, urban stormwater runoff and grazing are examples of land uses activities that have the potential to degrade water quality. The SWRCB has begun to define strategies to deal with NPS contamination and is developing a watershed management initiative (California State Water Resources Control Board 1995a), which focuses on voluntary measures and cooperative programs to reduce potential water quality threats.

Agricultural operations in California are as diverse as the geography. A wide variety of crops are grown under diverse soils, irrigation, and climatic conditions, making it difficult to prescribe globally applicable management practices which are appropriate for every conditions. The SWRCB recognizes that individually prescribed management practices should be specific to the unique crops, soils, and the potential risks to groundwater (California State Water Resources Control Board 1994). The Technical Advisory Committee for Plant and Nutrient Management was convened to assist in developing the "Initiatives in Nonpoint Source Management" (California State Water Resources Control Board 1995b), prepared to respond to nonpoint-source contamination in California. Technical Advisory Committee for Plant and Nutrient Management recommended that specific assessments of farming activities be conducted by agricultural experts familiar with unique agronomic conditions and local practices. It was anticipated that these assessments would be used to define appropriate best management practices (BMPs) to control nutrient leaching and to apply best available information and current research. Many of the concepts and programs contained in the watershed management program have been included in the GO and will serve to reduce the potentially significant impact to less then significant.

## Nitrate Management: Research, Technical Support and Technology Transfer on Agronomic Rates

DFA's FREP program was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. The program facilitates and coordinates the development of applied research and demonstration projects providing technical assistance and funding to carry out research, demonstration and education projects related to use of nitrogen fertilizers in agriculture. FREP also seeks to improve access to information on agronomic uses of nitrogen and to serve as a clearing house for data and research. Funding is provided by a tax on agricultural fertilizers. FREP is part of the Nitrate Management Program established by DFA in 1990 to identify nitrate sensitive areas and to reduce agriculture's contribution to nonpoint sources of nitrate

contamination. The information and research generated and distributed by FREP will assist in defining nitrogen agronomic rates for a range of crops and conditions found in California and to ensure compliance with prohibitions specified in the GO.

The Certified Crop Adviser (CCA) program has been developed by the American Society of Agronomy (ASA) in cooperation with agribusiness retail dealers, cooperatives and manufacturers, state and national trade associations, the U.S. Department of Agriculture (USDA), and independent consultants. The aim of this group was to develop a voluntary program for crop advisers that would: establish standards for knowledge, experience, ethical conduct and continuing education; enhance professionalism; and promote dialogue among those involved in agriculture and natural resource management. The CCA program is coordinated by the American Society of Agronomy and administered at the local level by state or regional boards. To become a Certified Crop Adviser, a person must have up to 4 years of crop advising experience, depending on educational background; document their education and crop advising experience with supporting references and transcripts; and pass comprehensive national and state/regional/provincial examinations that evaluate knowledge in four competency areas (soil fertility, soil and water management, integrated pest management, and crop management). CCAs can assist in determining agronomic rates for biosolids application to reduce the potential for nitrate leaching and groundwater contamination.

The University of California, California State University, local County Agricultural Extension Service offices, the U.S. Natural Resources Conservation Service, and USDA are all actively pursuing projects and research related to nutrient management and agronomic rates of nitrogen for various crop conditions in California. This information is being made widely available through local resource conservation districts, water districts, agricultural organizations and county agricultural commissioners. These same groups have been conducting research and demonstration projects to evaluate the effectiveness of on-farm BMPs for reducing nitrate contamination.

## Drinking Water Source Water Assessment and Protection Program

The California DHS Division of Drinking Water and Environmental Management is developing a program to assess the vulnerability of drinking water sources to contamination (California Department of Health Services 1999). This program, which is required by federal and state law, is called the Drinking Water Source Water Assessment and Protection (DWSAP) Program. DHS submitted its DWSAP Program Document to the EPA on January 19, 1999. The wellhead protection portion of the program has been approved by the EPA, and DHS anticipates receiving approval of the surface water component in mid-1999. Completion of drinking water source assessments is required by April 2003. The federal Safe Drinking Water Act (SDWA) requires states to develop a program to assess sources of drinking water and establish protection programs.

California's DWSAP Program is the first step in the development of a complete drinking water source protection program, and will include evaluation of both ground water and surface water sources. The groundwater DWSAP program includes components intended to fulfill the requirements for state development of a Wellhead Protection Program strategy as required by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect ground water sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land-use controls (usually applied at the local level in California) and other preventative measures can protect ground water. A Wellhead Protection Area (WHPA), as defined by the 1986 Amendments, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield". The WHPA may also be the recharge area that provides the water to a well or wellfield. The DHS's assessment includes a delineation of the area around a drinking water source through which contaminants might move and reach that drinking water supply. DHS must inventory possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area. This enables a determination to be made as to whether the drinking water source might be vulnerable to contamination. DHS is to conduct the surveys but local agencies may undertake the assessment.

An essential element of the drinking water source assessment program is an inventory of PCAs that are considered to be potential sources of contamination in the designated drinking water source areas and protection zones. Irrigated agriculture and land application of biosolids are recognized as PCAs. As such specific set back requirements from municipal and domestic wells and from surface water sources that provide drinking water will be required upon completion of the assessments and vulnerability analysis by DHS or locally responsible agencies. Biosolids application, along with agricultural applications of fertilizer, are classified as having a moderate potential risk of contaminating drinking water (California Department of Health Services 1999).

## Groundwater Management Plan (AB 3030)

Sections 10750-10756 of the California Water Code (AB 3030) were signed into law in 1992 and describes components that may be included in a ground water management plan developed by a local agency to protect groundwater. A total of 149 agencies have adopted groundwater management plans in accordance with AB 3030 (California Department of Water Resources 1994c). Each component would play some role in evaluating or operating a ground water basin so that ground water can be managed to maximize the total water supply while protecting ground water quality. Department of Water Resources Bulletin 118-80 defines groundwater basin management as including planned use of the ground water basin yield, storage space, transmission capability, and

water in storage (California Department of Water Resources 1975). Ground water basin management includes the following elements:

- protection of natural recharge and use of intentional recharge,
- planned variation in amount and location of pumping over time,
- use of ground water storage conjunctively with surface water from local and imported sources, and
- protection and planned maintenance of ground water quality.

The 12 components listed in Section 10753.7 of the Ground Water Management Act (AB 3030) form a basic list of data collection and operation of facilities that may be undertaken by an agency operating under this act. With respect to protecting groundwater from potential contamination from biosolids, the critical components to be included in local plans include the following:

- identification and management of wellhead protection areas and recharge areas;
- regulation of the migration of contaminated groundwater;
- administration of a well abandonment and well destruction program;
- monitoring of groundwater levels and storage;
- review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

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# Appendix E. Public Health Technical Appendix

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## Introduction

This appendix provides detailed information supporting the analysis presented in Chapter 5, "Public Health". Part 1 describes the potential pathogenic microorganisms that have been known to be present in sewage sludges and provides data on the incidence of reportable diseases in California on a county-by-county basis and for each year for the past 6 to ~~8~~ 9 years. Part 2 describes the U.S. Environmental Protection Agency's (EPA's) development of the national sewage sludge regulations (Part 503 regulations). Part 3 provides information on endocrine disruptors, an issue of increasing concern with regard to long-term impacts of chemicals in the environment.

## Part 1. Diseases of Interest

This section discusses each of the groups of potential pathogens of concern or specific potential pathogens of concern that may be found in biosolids and summarizes available information on the incidence of diseases they cause in California. This discussion is intended to provide background information for the impact analysis presented in Chapter 5. The information on disease incidence reflects the data collected by the existing statewide-public health reporting system, in which local health departments (three city and all county health departments) participate. The diseases that are reported are those that are diagnosed by a physician or at a hospital or clinic and represent only a small percentage of the actual cases which go largely unreported (for example the flu or an attack of gastroenteritis). For many diseases (amebiasis, campylbacteriosis, giardiasis, salmonellosis [other than typhoid fever], only summary counts of cases are reported to DHS and a thorough investigation by the local health department into each case of these diseases is not always conducted. Disease data is only reported for those whose illness results in a visit to a physician or local clinic or hospital, thus represents only a small percentage of the actual cases of illness that may occur. The true incidence of disease from pathogens causing gastroenteritis and other general symptoms that are normally treated with over-the-counter drugs will be underestimated and thus greatly affect any conclusions drawn from the disease incidence data reported herein.

The EIR reports only those cases reported and has contacted local health department personnel who might be knowledgeable about specific cases which might involve biosolids to obtain potential reports of interest to the GO evaluation of impacts.

NOTE: Many statistical tables previously presented (Numbered E1 through E16 in the text have been revised and corrected to include all available data are now at the end of the appendix in order. There are revised tables (E-1a through E-16a ) for all reported diseases which include data for the years 1990-1998 (provisional statistics for the years 1996, 1997 and 1998 are included since minor adjustments to the records are still occurring). Each disease type has two tables. The first designated by a number and an "a" shows the number of reported disease cases by county or local health department. The second designated by a "b" (numbered E-1b through E-16b) shows the same information converted to an incidence rate based on the population of the city of county in which the disease was reported. This information was added at the request of the California Department of Health. Note that these numbers were calculated based on population estimates from the California Department of Finance. The disease statistics were provided by the California Department of Health Services. The data base they provided has been sorted and tabulated. Minor adjustments were made to the 1990 data to account for changes in the combined Humboldt/Del Norte County separation of reporting in subsequent years.

## Bacterial Diseases

### Enterotoxic *E. coli* O157

This mutant form of *E. coli* first appeared in the United States in 1982 and is one of hundreds of varieties of *E. coli* found in the intestinal tract of mammals (Padhye and Doyle 1992). It is mainly an infection in cattle that can be passed to humans who eat foods contaminated by cattle manure (even in organic gardens using uncomposted manure) or who eat inadequately cooked meat (Cieslak et al. 1992, Centers for Disease Control 1993, Nelson 1997). This particular variety, according to Wells et al. (1991), can be found in 1%–3% of all cattle in the United States but causes them no harm. The infection can be serious for a human host, however, causing severe, often bloody diarrhea. In the worst cases, particularly in young children, *E. coli* can kill. Most often, *E. coli* illnesses are associated with eating undercooked hamburger or uncooked fruits (apples and cantalopes) and vegetables (lettuce in particular) or with person-to-person contact (Belongia et al. 1993, Nelson 1997). Contaminated water supplies are also of growing concern (Jones and Roworth 1996). This particular bacterial strain is of growing concern as more outbreaks occur (Koutkia 1997).

The most well-publicized recent case of illness from *E. coli* is that of three children who died in Washington in 1993 after eating contaminated hamburgers at a fast-food restaurant (Centers for Disease Control 1993). In summer 1997, 25 million pounds of hamburger,

potentially tainted with *E. coli* O157:H7, were recalled by Hudson Foods in Columbus, Nebraska, after consumer illnesses were reported. Illness caused by *E. coli* O157:H7 has been a reportable disease in California since 1993 after the first case was reported in San Diego County in 1992; the annual number of cases has ranged from 1 to 264, and occasional outbreaks have occurred throughout California (Table E-1a). Table E-1b shows the incidence rates for the various reporting entities.

**[Note: draft EIR Table E-1 has been deleted and is being replaced by Tables E-1a and E-1b at the end of document.]**

Like other pathogens of concern, the enterotoxic form of *E. coli* has a low infectious dose (estimated to be as low as 10 bacteria).

The present detection method for *E. coli* O157:H7 requires growing the bacteria in laboratory cultures, which takes days. A group of Montana researchers led by Dr. Gordon McFeters has developed a new method using an antibody test kit. The test takes only 4 hours; is highly sensitive; and works in food, feces, and water. The method could be adapted to detect other foodborne pathogens, such as *Salmonella*, and could be used at various points in beef supply processing to check for contamination.

## Campylobacteriosis

*Campylobacter jejuni*, like *E. coli*, can cause severe cases of gastroenteritis (campylobacteriosis) and has been consistently listed as a pathogen of concern in relation to sludge management (U. S. Environmental Protection Agency 1985) despite a lack of information on its densities in sludges. This pathogen has outranked *Salmonella* as a leading cause of bacterial diarrhea (as in 1996), particularly in infants (Table E-2a). The reported incidence of gastroenteritis attributable to *C. jejuni* in California has ranged from 6296 to 8220 cases annually since 1990 (Table E-2a). A large percentage of the cases were reported to have occurred in Los Angeles County. Several hundred cases were reported in the three counties of the Central Valley where most of the biosolids land application occurs (see Chapter 5). Table E-1b shows the incidence rates for the various reporting entities.

Little has been reported in scientific literature about the levels of this pathogen in feces shed by ill people, its removal in treatment, levels in biosolids, infectious dose, or longevity in the environment (Feachem et al. 1980, U.S. Environmental Protection Agency 1985) as indicated in (Table 5-1 of Chapter 5).

**[Note: draft EIR Table E-2 has been deleted and is being replaced by Tables E-2a and E-2b at the end of document.]**

## Salmonellosis and Typhoid Fever

The bacterial genus *Salmonella* consists of more than 2,000 known serotypes found in different reservoirs and locations, many of which are pathogenic to humans and other animals (Argent et al. 1977, 1981; Ayanwale 1980; Mishu et al. 1994). Ingestion of an infectious dose of *Salmonella* (usually a large number of bacteria is required, as shown in Table 5-1 in Chapter 5) can result in gastroenteritis, enteric fever, and/or septicemia. The two major disease syndromes associated with *Salmonella* are salmonellosis (gastroenteritis) and typhoid fever (enteric fever).

**Salmonellosis.** The major vehicle of salmonellosis is food (St. Louis et al. 1988, Mishu et al. 1994), although waterborne outbreaks have occurred. There are many zoonotic reservoirs for salmonellosis, including such domestic and wild animals as poultry, swine, cattle, rodents, dogs, cats, and reptiles. Waterborne outbreaks of salmonellosis occur worldwide and are associated primarily with fresh water.

Salmonellosis is characterized by acute abdominal pain, diarrhea, nausea, fever, and dehydration and is sometimes accompanied by vomiting. The illness can lead to complications and more serious infections. Death is not common except in the very young, the very old, or the debilitated.

It has been estimated that 400,000 to 3.7 million cases (17.3 cases per 100,000) of salmonellosis (including foodborne and waterborne transmission) occur every year in the United States (EOA 1995), with as many as 70% of the cases being imported from foreign travelers. Between 4,739 and 6,544 cases have been reported yearly in California over the past nine years (Table E-3a), with over 25% of the total being reported in Los Angeles County. Table E-1b shows the incidence rates for the various reporting entities. The incidence rates for California counties are typical of those reported nationwide ranging from 0 - 151.7 cases/100,000 with the highest rates being found the rural counties with low populations where a single case makes a big difference. Central valley counties were biosolids use is extensive do not appear to have any higher rates in recent years than other localities.

Recent research on the causes of a *Salmonella* outbreak among chickens has raised concern about the importance of *Salmonella* in wastewater management and indicates the need for constant vigilance and monitoring of the effectiveness of management techniques and disinfection methods (Kinde et al. 1996, 1997). Concern also exists regarding the transmission of *Salmonella* from biosolids to animals (Jones et al. 1980; Argent et al. 1977, 1981) and the ability of the pathogen to survive under hostile environmental conditions (Droffner and Brinton 1995); this ability makes them the indicator of choice for monitoring the effectiveness of biosolids pathogen reduction (U.S. Environmental Protection Agency 1992). In developing the Part 503 regulations, the EPA based its requirements for pathogen reduction and its risk assessments for protection of public health on *Salmonella* because of

its high incidence rates, its ability to regrow, and its correlation with coliform bacteria (about 1.4 *S. typhi* per million 100,0000 coliforms based on a morbidity rate of 0.0018/100,0000 persons).

**Typhoid Fever.** Typhoid is transmitted via water or food contaminated by the feces or urine of a carrier. Fruits, vegetables, and milk contaminated by sewage or by the hands of carriers are also modes of transmission. The case-fatality rate for typhoid fever can reach 10% if symptoms go untreated; there are approximately 500 fatalities per year (0.2 per 100,000 deaths per year) in the United States.

**[Note: draft EIR Table E-3 has been deleted and is being replaced by Tables E-3a and E-3b at the end of document.]**

## Shigellosis

The genus *Shigella* is made up of four species of rod-shaped bacteria that are all pathogenic in humans and other primates. The four species are characterized as groups or types: Group A, *S. dysenteriae* (10 serovars); Group B, *S. flexneri* (17 serovars); Group C, *S. boydii* (15 serovars); and Group D, *S. sonnei* (1 serovar). Shigellosis, an acute bacterial disease caused by *Shigella*, occurs worldwide, with outbreaks common under conditions of crowding and poor sanitation (i.e., jails, institutions for children, mental hospitals, crowded camps and ships). The reporting for the disease distinguishes between the four groups to help identify the sources and potential severity of the infection. From 1967 to 1988, annual isolation rates of *Shigella* reported to the Centers for Disease Control (CDC) varied between about 5 and 10 per 100,000 persons. It has been estimated that 5% of all symptomatic cases of shigellosis are reported to the national surveillance system. *Shigella* is considered the most highly communicable of the bacterial diarrheas; as few as 10 organisms have been reported to cause clinical illness (U. S. Environmental Protection Agency 1985).

For *S. dysenteriae* (Shiga bacillus) infection, case-fatality rates approach 20%; for *S. sonnei infection*, the infection is short-lived and the fatality rate is almost negligible, except in immunocompromised persons. Few cases are reported in California. The annual number of cases reported in the state ranges from 24 to 110 cases a year for Group A, 770 to 1957 for Group B, 87 to 232 for Group C, and 1522 to 3144 for Group D (Tables E-4a, E-5a, E-6a, and E-7a, respectively). Some 572 - 817 cases a year were unidentified as to type (Table E-8a). Incidence rates for the counties in which cases were reported for the various types are shown in Tables E-4b, E-5b, E-6b, and E-7b. Reported incidence rates are low except for a few counties in urban areas or where remote outbreaks occur in the rural counties. None of these cases has been associated with biosolids.

*Shigella* spp. has in the past been the most common bacterial pathogen implicated in waterborne outbreaks in the United States, but its occurrence has declined over time (Moore et al. 1993). Shigellosis also has been implicated in outbreaks associated with recreational swimming (Blostein 1991, Sorvillo et al. 1988).

Shigellosis is transmitted via the fecal-oral route, directly or indirectly, primarily from person to person via contaminated food and water. In areas of poor sanitation, food and water may play a greater role in transmission. Flies have been shown to be a vector in the transmission of the disease (Dunaway et al. 1983).

The survival of *Shigella* in water, soils, and plants depends on factors such as temperature and the concentration of other bacteria, nutrients, and oxygen. In various studies, *Shigella* has been shown to survive for up to 22 days in well water and even longer in colder temperatures (47 days) and up to 135 days in permafrost soils of Siberia (EOA 1995).

One detailed review of the scientific literature performed by EOA (1995) found no *Shigella* outbreaks associated with water where the source met the coliform standards at the time of exposure.

**[Note: draft EIR Tables E-4 to E-8 have been deleted and are being replaced, respectively, by Tables E-4a and E-4b, E-5a and E-5b, E-6a and E-6b, E-7a and E-7b, and E-8a and E-8b. All sets of tables appear at the end of document.]**

## Protozoan Diseases

### Amoebiasis

Amoebiasis, an infection caused by the environmentally resistant pathogen *Entamoeba histolytica*, is acquired by mouth contact. Symptoms can vary from minor abdominal cramps to severe diarrhea alternating with constipation. The incidence of disease from this protozoan is low; between 698 and 1,646 cases per year have been reported in California over the past nine years (Table E-9a) with a general decline in the rate over time.. None of the reported cases have been associated with biosolids or wastewater management, however, most cases are not investigated t the extent to make a definitive association. A majority of the reported cases in California were in Los Angeles County (including Long Beach and Pasadena), San Francisco and Santa Clara counties reflecting the size of the population and high number of travelers from these areas. This disease is associated often with travel in other countries, particularly in areas of Mexico. Incidence rates are shown in Table E-9b which show that San Francisco and Santa Barbara have experienced the highest reported rates in recent years.

**[Note: draft EIR Table E-9 has been deleted and is being replaced by Tables E-9a and E-9b at the end of document.]**

### Crytosporidiosis

Cryptosporidiosis is a gastrointestinal infection that is caused by the protozoan *Cryptosporidium* spp. *Cryptosporidium* oocysts are shed by humans and animals in feces.

The infectious dose in humans is thought to be small; it is 10–400 oocysts in species other than humans. Little is known about the concentrations of viable oocysts in biosolids (Gerba pers. comm.) and the viability of oocysts in the environment, but oocysts are known to have the potential to survive months following their excretion (EOA 1995) and have the potential to survive more than a month following sludge treatment and land application (Whitmore and Robertson 1995). However, it has been found that conventional treatment and anaerboic digestion are effective in reducing the numbers of oocsysts in biosolids (Whitmore and Robertson 1995).

Modes of transmission for cryptosporidiosis include person-to-person contact, zoonotic transmission, and contaminated food and water. Person-to-person transmission is probably the most important mode and has been documented among family/household members, sexual partners, health workers and their patients, and children in day care centers. *Cryptosporidium* readily crosses host-species barriers as well, though, and human infections are often the result of zoonotic transmission. *Cryptosporidium* is harbored by more than 40 mammals. Reservoir hosts include calves, dogs, cats and rodents (Tzipori 1988).

Several waterborne outbreaks of cryptosporidiosis have been reported in the United States where the filtration component of water treatment was suboptimal (Milwaukee, for example - see below) (McKenzie et al. 1994). Cryptosporidiosis also has been associated with recreational use of swimming pools (Joce et al. 1991). Disease incidence in England associated with chlorinated water supplies and swimming pools indicates cryptosporidiosis resistance to chlorination (Furtado et al. 1998).

During a waterborne outbreak of cryptosporidiosis resulting from contamination of a public water supply that affected an estimated 13,000 people in Georgia, routine samples from the water system were found to meet EPA and State of Georgia standards for coliform bacteria (Robertson and Smith 1992). During another cryptosporidiosis outbreak associated with public water supply that led to an estimated 403,000 cases of diarrhea in Milwaukee, coliforms were not detected in samples of treated water (McKenzie et al. 1994). It should be noted that it is generally recognized that *Cryptosporidium* oocysts are removed or inactivated by effective and reliable water treatment practices where the water supply is not contaminated by dairy or pasture runoff (most often from flooding).

*Cryptosporidium* is found worldwide. Human cryptosporidiosis has been reported in at least 60 countries on six continents, with widely varying prevalence among those seeking medical care for diarrhea (EOA 1995). The prevalence is highest in non-industrialized regions: Europe,1% to 2%; North America, 0.6% to 4.3%; and Asia, Australia, Africa, and Central and South America, 3% to 20%. Seroprevalence rates in immunocompetent individuals are between 25% and 35% in the United States and are well over 50% in Latin America. Children generally have a significantly higher prevalence than adults, and infections are often seasonal, with a higher prevalence during warmer, wetter months.

No outbreaks associated with biosolids use have been reported in scientific literature or with the health agencies consulted during the preparation of this EIR. This disease is rare, with 311 to 6,141 cases a year reported in California for both types of Cryptosporidiosis, few of

which are from areas where biosolids have been land applied (Tables E-10a and E-11a). Tables E-10b and E-11b show the incidence rates fo the two types of Cryptosporidiosis which have been their highest in remote Sierra County and in the San Francisco area and otherwise are quite low.

**[Note: draft EIR Tables E-10 and E-11 have been deleted and are being replaced, respectively, by Tables E-10a and E-10b, and E-11a and E-11b at the end of document.]**

## Giardiasis

*Giardia lamblia* is a protozoan that principally infects the upper small intestine in humans, who can often be asymptomatic. *Giardia* infection, or giardiasis, manifests itself in the form of chronic diarrhea, abdominal cramps, weight loss, and fatigue that can last for months with relapses. It can progress to cause malabsorption syndrome, in which digestion is impaired and weight loss occurs. Certain immunodeficiency syndromes also may be associated with *Giardia* infection, and the infection is particularly devastating in immunocompromised persons. Carriers can shed *Giardia* for years, but a self-cure usually occurs within 2 to 3 months. The numbers of *Giardia* cysts shed in feces are highly variable but have been measured to be as high as 900 million per day (Feachem et al. 1983).

Before leaving the intestine, *Giardia* generally forms a resistant cyst, which is highly resistant to traditional disinfection techniques (EOA 1995). The cysts can remain viable in water for several months and can remain viable in soils as well, but cannot tolerate freezing (EOA 1995). It has been found that the presence of traditional bacterial indicators does not correlate with the presence of cysts, particularly in unfiltered but disinfected drinking water (EOA 1995). Negative coliform tests do not provide assurance that water is free of *Giardia* cysts; however, positive coliform results often correlate with *Giardia* outbreaks (EOA 1995).

The major reservoir of *Giardia* is humans, but there is evidence that humans may acquire infections from other animals. Beavers may be a reservoir and have been implicated in waterborne outbreaks (EOA 1995). Dogs, gerbils, guinea pigs, beavers, raccoons, bighorn sheep, and muskrats have all been shown to be carriers of *Giardia* (EOA 1995).

*Giardia* infection is transmitted through contaminated water supplies, foodborne outbreaks, and person-to-person contact, with the later being the most prevalent means of transmission. Individuals with impaired immune function appear to have increased susceptibility to *Giardia* infection.

The numbers of *Giardia* cysts in biosolids have been estimated to range from 10 to $10^3$ per gram with no removal via treatment. However, significant viability reduction occurs during digestion, estimated in laboratory studies to be as high as 99.9% inactivation (Straub et al. 1993, Cravaghan et al. 1993). Class A treatment requires that treated biosolids contain less than one protozoan cyst per gram. For Class B sludge generated in Australia, it has been

found that anaerobically digested and mechanically dewatered sludge had cysts present at levels of public health concern after 1 year, but that cysts were destroyed after only 12 weeks following soil amendment (Hu et al. 1996).

*Giardia* is found worldwide. The prevalence of *Giardia* infection worldwide has been estimated to be about 7%, and infection is more common in children than adults. Prevalence rates vary between less than 1% and 50% and depend on the population sampled, infection rates being highly dependent upon sanitation and the quality of drinking water. Areas of the United States known to be associated with increased risk of infection are usually mountainous and include New England, the Pacific Northwest, and the Rocky Mountains.

The number of cases reported in California is variable, ranging from 4,029 to 7,850 per year (Table 5-6 in Chapter 5) and Table E-12a. The incidence in California is the highest in Los Angeles County. The number of reported in Kern, Merced, and Kings Counties, where the majority of the biosolids application currently occurs (Table E-12a) have shown a slight declining trend and moderate incidence rates. No cases of the illness associated with biosolids operations have been reported (Cook and Shaw pers. comms.). Overall incidence rates are highly variable as shown in Table E-12b.

**[Note: draft EIR Table E-12 has been deleted and is being replaced by Tables E-12a and E-12b at the end of document.]**

## Viruses

### Hepatitis A

The hepatitis A virus (HAV) is a virus physically resembling an enterovirus that causes hepatitis A, an illness with the symptoms of fever, nausea, malaise, anorexia, and abdominal discomfort, followed by jaundice. The disease can be mild, lasting 1 to 2 weeks, or severe, with disabling effects lasting months in rare cases. The recovery period is usually prolonged. The case-fatality rate has been reported to range from 0.04% in children 5–14 years old to 2.7% in adults over 49 years old, with typical case-fatality rates of 0.1–0.5%. Relapse rates can be as high as 20%. Hepatitis A can be diagnosed by the detection of virus in the stool or the presence of IgM antibodies against HAV in the serum of persons who are acutely ill. There is currently no specific treatment for HAV.

The normal reservoir of HAV is acute-phase humans; there is no known carrier state. Mode of transmission is via the fecal-oral route, with person-to-person transmission being the most frequent means of transmission, usually via water or food. HAV can survive for long periods on inanimate objects and on human hands; therefore, food contamination by infected persons is a major area of concern. In the United States, waterborne outbreaks have been estimated to contribute 0.4%–8% of all HAV incidence, and no waterborne disease outbreaks have been shown to have been directly associated with biosolids. The majority of waterborne outbreaks in the United States involve small private or semiprivate water supplies with or

without chlorination; these outbreaks are usually attributable to plumbing-sewage cross-contamination or to a raw-water source being so grossly polluted with sewage that virus levels cannot be eliminated by treatment of the water using conventional methods. The infectious dose is estimated to be in the range of 1 to 10 plaque-forming units (PFUs).

Little is known about persistence of hepatitis A in the environment. Survival in water has been recorded for as long as 40 days in surface waters and 70 days in groundwaters (EOA 1995). Levels in biosolids have not been reported in anaerobically digested sludge.

There is no known direct correlation between HAV and indicator organisms such as coliform bacteria, fecal streptococci, acid-fast bacteria, or coliphage.

Hepatitis A has a worldwide distribution. Since 1920 in the United States, there have been about 15 reported outbreaks of HAV associated with drinking water, most of which are reported from areas with poor sanitation or contaminated water supplies (Singh et al. 1998). In California, the number of Hepatitis A cases has ranged from 4,197 to 6,773 annually over the past nine years (Table E-13a) with a relatively variable incidence rates (Table E-13b) in individual areas with only a few cases contributing to high rates in the smaller counties (Del Norte, Sierra, and Humbolt counties).

Incidences in counties where biosolids are being land applied have not increased since land application was intensified in recent years, and no cases have been reported in most instances in the past nine years. None of the cases reported can be related to the handling or use of biosolids.

**[Note: draft EIR Table E-13 has been deleted and is being replaced by Tables E-13a and E-13b at the end of document.]**

## Viral Meningitis

"Viral meningitis" is the general term that refers to all serious viral diseases (not gastroenteritis of unknown origin) that have been reported. Included as causative agents and reportable as viral meningitis are the Coxsackievirus A and B, Echovirus, and new enteroviruses (acquired orally). It is unknown how many viruses cause gastroenteristis and flu-like symptoms that are unreported. The reportable cases of viral infections have ranged from 1,146 to 3,648 per year (Table E-14a). Most of the cases are reported in the more urbanized counties and the numbers of reported cases are largely proportional to population. Recent years have shown a decline in the number of reported cases in Kern County where large-scale land application is presently practiced. There is no reported information indicating that any of the cases are associated with biosolids land application operations. Incidence rates over time have been highly variable in most areas and generally moderate as shown in Table E-14b.

**[Note: draft EIR Table E-14 has been deleted and is being replaced by Tables E-14a and E-14b at the end of document.]**

## Gastroenteritis

Gastroenteritis is a widespread disease that can be caused by numerous known and unknown viral agents. Person-to-person transmission is the principal mechanism for the spread of many infections; therefore, the most important element in preventing and controlling outbreaks is improved environmental hygiene (i.e., food, water, and sanitation).

When foods other than shellfish are implicated in viral gastroenteritis outbreaks, the contamination has usually taken place near the point of consumption (shellfish are not discussed in this EIR because of the nature of the project). Ill food handlers were identified in nine of the 15 documented Norwalk outbreaks reported to the CDC from 1985 to 1988 for which adequate epidemiologic data were available (Centers for Disease Control unpublished data). Foods that require handling and no subsequent cooking (e.g., salads) constitute the greatest risk. Among Norwalk-confirmed foodborne outbreaks from 1976 to 1980 that were not attributable to shellfish, salad was the most commonly implicated food (Centers for Disease Control 1999).

The long list of foods implicated in outbreaks of viral gastroenteritis reflects the variety of foods handled by food-service personnel and the low infectious dose (10–100 particles) of most viral agents of gastroenteritis. In contrast to the factors important in amplifying bacterial contamination, practices such as leaving foods unrefrigerated or warming them for prolonged periods are not direct risk factors for increased viral transmission because the viruses do not multiply outside the human host.

The Norwalk agent can remain infective even if frozen for years or heated to 60EC for 30 minutes. Cooking temperatures at 100EC or above are probably adequate to inactivate Norwalk and most other enteric viral pathogens.

Outbreaks of viral gastroenteritis have been associated with various sources of contaminated water, including municipal water, well water, stream water, commercial ice, lake water, and pool water (Centers for Disease Control 1999). Disinfection of municipal supplies may not be adequate to kill the Norwalk agent, which can remain highly infective despite 30-minute exposure to concentrations of chlorine as high as 6.25 milligrams per liter (mg/l) and levels of 10 mg/l (Centers for Disease Control 1999); this helps explain why this virus is predominant in waterborne disease outbreaks. Rotavirus, for which only one waterborne outbreak has been documented in the United States, is more sensitive to chlorine than the Norwalk agent.

Because rotaviruses can survive for several days on nonporous materials in conditions of low temperature and humidity, objects may contribute to their transmission. A recent study of a Norwalk viral outbreak on a cruise ship implicated toilets shared between staterooms as a risk factor for infection, suggesting that surfaces contaminated by Norwalk particles from spattered or aerosolized material may play a role in transmission of Norwalk-like viruses causing gastroenteritis.

Aerosolized rotavirus has also been observed to caused diarrheal illness in experimental mice. Studies are needed to address the efficacy of barrier precautions (e.g., face shields, respirators) in interrupting transmission of these agents (Centers for Disease Control 1999).

Contaminated hands (hands contaminated directly or through contact with contaminated surfaces) may be the most important means by which enteric viruses are transmitted; thus, any people involved with biosolids should avail themselves of handwashing with soap on a routine basis to control the spread of all enteric pathogens.

Nearly all the agents of viral gastroenteritis in humans have related strains that can cause diarrhea in animal species. These strains appear to be highly host-specific, however, and zoonotic transmission has not been documented as having an important role in human disease, either endemically or in outbreaks.

### Acquired Immune Deficiency Syndrome (AIDS/HIV Virus)

No discussion of viruses would be complete without a discussion of acquired immune deficiency syndrome (AIDS), which is caused by HIV (human immunodeficiency virus). It is noteworthy that HIV has never been recovered from wastewater samples into which it has not been artificially introduced (Ansari et al. 1992, Casson et al. 1992, Moore 1993). Researchers have recovered viral nucleic acid fragments in wastewater but none in biosolids (Preston et al. 1991). However, the detection of nucleic acid sequences does not represent the presence of viable HIV. No intact HIV has been recovered from either raw sewage or biosolids. The CDC contends that wastewater treatment professionals, as well as members of the public who may contact wastewater or biosolids, are not at risk of contracting AIDS as a result of this contact (Centers for Disease Control 1999).

## Parasitic Worms

Several parasitic intestinal worms are found in wastewater (Straub et al. 1993, ABT Associates 1993). These parasites are a potential hazard to the public health in general and to treatment plant and biosolids workers in particular. The beef tapeworm (*Taenia saginata*) can cause taeniasis if ingested with poorly cooked meat. Tapeworm eggs are detectable in biosolids, but there is no evidence that they have contributed to distribution of the disease except in one reported case discussed below.

### Toxoplasmosis

Toxoplasmosis is a very rare disease that affects only unborn fetuses. The disease is derived from cat feces. As shown in Table E-15a, between 9 and 192 cases per year have been reported in California, one of which were in areas (Merced County) where biosolids are being extensively land applied. A majority of the cases were in Los Angeles County except

for an outbreak in San Francisco in 1990 where 148 cases were reported that year. Incidence rates for this disease are very low as shown in Table E-15b.

**[Note: draft EIR Table E-15 has been deleted and is being replaced by Tables E-15a and E-15b at the end of document.]**

## Roundworms

Ascariasis is caused by the presence of roundworms (*Ascaris lambricoides*) in the intestinal tract. The disease results from the ingestion of roundworm eggs, which survive for months to years in biosolids (Table 5-1 in Chapter 5) and were a primary focus of the EPA Part 503 regulation risk management practices. This disease occasionally occurs and is not a reportable disease in California.

## Hookworms

Hookworm disease, rare in California but still present in the southeastern United States, is generally acquired when the larvae of *Necator americanus* enter through the bare skin, usually the feet. Infections also have occurred following ingestion of foods contaminated by wastewater. No cases of transmission related to biosolids land application have been reported. Symptoms include malnutrition, loss of energy, and anemia. This disease is rare and has not been reported in the past 6 years.

## Tapeworms

There are two species of tapeworms (*Taenia saginata* [beef] and *T. solium* [pork]) that live in the intestinal tract, where they can cause abdominal pain, weight loss, and digestive disturbances (Straub et al. 1993). Humans serve as the definitive host for the adults, and the eggs, which are passed in feces, may not be completely destroyed by all sludge treatment processes (Feachem et al. 1983), thus leading to the potential for their application to land in biosolids. If cattle graze on this land and ingest viable larvae, the disease may be transmitted to cattle. Humans have to become infected from eating incompletely cooked meat containing the larval stage of the tapeworm. A single recorded case of beef tapeworm transmission through the fertilization of land with untreated sludge has been reported in the United States; this case was reported more than 20 years ago, however, before the development of the Part 503 regulations and the improvements in treatment mandated under the Clean Water Act (Hammerberg et al. 1978).

Tapeworm infections are relatively rare in California; a maximum of 46 cases per year have been reported when an outbreak of 27 cases was reported in Santa Clara County (Table E-16a). A single case was reported in Kern County in 1997. Incidence rates for this diseare are very low as shown in Table E-16b.

**[Note: draft EIR Table E-16 has been deleted and is being replaced by Tables E-16a and E-16b at the end of document.]**

## Fungal Diseases

Fungal pathogens include several species that have been identified in biosolids, as listed below.

| Fungal Species | Disease |
|---|---|
| *Aspergillus fumigatus* | Aspergillosis |
| *Candida albicans* | Candidiasis |
| *Cryptococcus neoformans* | Subacute chronic meningitis |
| *Epidermophton* spp. and *Trichophyton* spp. | Ringworm and athlete's foot |
| *Trichosporon* spp. | Infection of hair follicles |
| *Phialophora* spp. | Deep tissue infections |

Most of these fungal species have been found associated with composting operations, where they are enhanced by the favorable conditions created (wood chips and heat).

Aspergillosis is illness caused by the *Aspergillus* fungus, which is found commonly growing on dead leaves, stored grain, compost piles, or other decaying vegetation. The fungus can cause illness in three ways: as an allergic reaction in people with asthma (pulmonary aspergillosis, allergic bronchopulmonary type); as a colonization in an old lung cavity that has healed from previous disease such as tuberculosis or in a lung abscess, where it produces a fungus ball called aspergilloma; and as an invasive infection with pneumonia that is spread to other parts of the body by the blood stream (pulmonary aspergillosis; invasive type). The invasive infection can affect the eye, causing blindness, and any other organ of the body, but especially the heart, lungs, brain, and kidneys. The third form occurs almost exclusively in people whose immune systems are suppressed by high doses of cortisone drugs, chemotherapy, or a disease that reduces the number of normal white blood cells. Those at risk include organ transplant recipients and people with cancer, AIDS, or leukemia (Rosenberg and Minimato 1996).

The A*spergillus* group of fungi is generally less prevalent than other fungal species, but it can be pathogenic to people under conditions of high exposure. Normal background levels of *Aspergillus fumigatus* outdoors rarely exceed 150 spores per cubic meter.

Composting facilities do represent sites where there occurs a massive culturing of *Aspergillus fumigatus* organisms in relatively small areas compared with most "natural" or background circumstances. Studies have found concentrations of *A. fumigatus* 10 times higher than background levels in active commercial composting facilities, but the concentrations fell off sharply within 500 feet of the operational site (Clark et al. 1983) If

the nearest human receptor is beyond the point at which concentrations fall to background levels, no elevated exposure is occurring.

The use of bark or wood chips (e.g., as a bulking agent for sewage sludge composting) typically raises the onsite level of airborne *A. fumigatus* spores (Millner et al. 1977, 1980; Clark et al. 1983). In one study in Maryland, *A. fumigatus* levels in sewage sludge rose from $10^2$ or $10^3$ colony forming units per gram dry weight (CFU/gm dry wt) to $2.6 \times 10^6$ to $6.10 \times 10^7$ CFU/gm dry wt when mixed with wood chips that were stockpiled for various lengths of time. The increase appeared to be caused by wood chips being stored in moist piles that were allowed to generate heat (Millner et al. 1977).

Increased *A. fumigatus* spore concentrations have been observed also in screened compost; the concentrations may have been increased as a result of reinoculation by spores as compost passed through contaminated screens multiple times (Olver 1979); others have suggested that multiple screenings may break up spore clusters, causing more spores to be released.

Numerous researchers (Raper and Fennel 1965; Sinski 1975; Olver 1979; Epstein and Epstein 1985, 1989; Maritato et al. 1992; Epstein 1993) have presented persuasive arguments regarding the lack of health risk from *A. fumigatus* for certain outdoor workplace environments. In enclosed compost facilities without dust control, there is an elevated risk of worker exposure to spores. In a worst-case scenario, a respiratory model developed by Boutin et al. (1987) estimated that a completely unprotected worker shoveling mature compost at a highly contaminated site could inhale 25,000 to 30,000 viable spores per hour. However, elevated exposure is not automatically synonymous with an elevated health risk for compost workers (or neighboring communities). Epstein (1993) discusses several composting facilities in the United States in which health monitoring (physical examinations) of compost workers has been conducted; the results of the physical examinations did not reveal any illnesses directly associated with composting.

Many public health specialists, scientists, and engineers in North America and Europe believe that properly operated composting and co-composting operations present little health risk to normal compost facility employees and present a negligible risk or no risk to nearby residences (Millner et al. 1977, Clark et al. 1983, Epstein and Epstein 1985, Boutin et al. 1987, Maritato et al. 1992). Diaz et al. (1992) stated:

> The existence of hazard from the spores of *A. fumigatus* [at commercial composting facilities] is yet to be demonstrated. The infectivity of the spores is low. Consequently, any danger posed by it would be of significance only to the unusually susceptible individual. Nevertheless, use of respirators by workers and the siting of such facilities in areas remote from residential dwellings and areas where potentially sensitive receptors work of live is warranted as a prudent land use planning practice.

Reducing the dispersal of *A. fumigatus* spores appears to be the best way to reduce exposure and help protect the health of compost workers and the neighboring communities.

The following management practices can help reduce the dispersal of spores into the air during commercial aerobic composting operations (whether they involve windrows, aerated static piles, or the various types of in-vessel reactors— vertical, horizontal, or rotating drum):

- suitable siting, design, and construction (berms, vegetation, etc.) of composting facilities;
- implementation of facility operational practices such as dust suppression, modification of time of operation, etc.);
- engineering and administrative controls (enclosed cabs, use of amendment materials, health checks for workers); and
- use of personal protective equipment (respirators or protective masks).

The California Integrated Waste Management Board's current green waste composting regulations require a setback of at least 300 feet of the facility's active compost materials areas from any residence, school, or hospital, excluding onsite residences, unless a variance is granted from the local enforcement agency. More stringent requirements can be applied where there are sensitive receptors; high winds; or other factors related to health risks, such as the health status of the community potentially affected.

## Pathogens of Emerging Concern

Research techniques continue to be developed for determining the pathogenic microorganisms responsible for human and animal disease outbreaks. New genetic techniques and electron microscopy have improved our ability to detect and identify pathogens, particularly new viruses. Because approximately 50% of all cases of gastroenteritis are of unknown origin, such research is vital to development of our understanding of disease and disease prevention.

This section describes the results of a literature review of recent outbreaks of disease (worldwide) undertaken to identify some of the emerging pathogens and their possible modes of transmission. Emerging pathogens are organisms responsible for new, reemerging or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future. Included are such pathogens as *E.coli* O157:h7 and *Cyclospora* which have caused several outbreaks in California. The results of this search are summarized in Tables E-17 and E-18 for bacteria and viruses, respectively. Table E-19 provides information on parasites. None of these potential pathogens of concern have yet been identified with the use or handling of biosolids. Most outbreaks are associated with poor sanitation or food preparation and handling or drinking of contaminated water.

The patterns of incidence and pathways of spread for various pathogens are poorly understood. Epidemiological studies have revealed some interesting findings with regard to crytposporidiosis that show how incidence of disease and causative factors are difficult to identify: evaluation of health records and water treatment plant records revealed that outbreaks of cryptosporidiosis were occurring in Milwaukee for more than a year before the large documented outbreak in 1993 (when high runoff occurred, the water treatment plant turbidity levels became very high, and treatment levels declined) (Morris et al. 1998).

Table E-17. Bacterial Pathogens of Emerging Concern

| Pathogen | Disease | Source | Environmental Sources | Outbreaks Reported | Literature |
|---|---|---|---|---|---|
| *Aeromonas* spp. (332 types) | Gastroenteritis | Pigs, chickens, ground beef, human feces, fish, milk, vegetables | Drinking water, fresh water, and wastewater | None from biosolids | Wadstrom and Ljungh 1991, Hanninen and Siitonen 1995 |
| *Pleisomonas shigelloides* | Gastroenteritis | Seafoods | Contaminated seawater | None from biosolids | Wadstrom and Ljungh 1991 |
| Hepatitis E | Hepatitis | Human feces | Sewage-contaminated water supply | None from biosolids; water related only. | Singh et al. 1998 |
| *Helicobacter* sp. | Unknown | Wastewater, treated water, well water | Contaminated supplies | None from biosolids | Hulten et al. 1998 |
| *Salmonella enteritidis* PT6 | Salmonellosis | Eggs | Foodborne contamination | None from biosolids | Evans 1998, St. Louis et al. 1988, Mishu et al. 1994 |
| *Salmonella enteritidis* PT4 | Salmonellosis | Wastewater to mice to chickens | Treated secondary effluent discharged to surface water | None from biosolids | Kinde et al. 1996, Kinde et al. 1997 |

Table E-18. Viral Pathogens of Emerging Concern

| Pathogen | Disease | Source | Environmental Sources | Outbreaks Reported | Literature |
|---|---|---|---|---|---|
| Adenoviruses 40 and 41 | Gastroenteritis | Humans | Unknown | None from biosolids | Enriques et al. 1995 |
| Human torovirus | Gastroenteritis and diarrhea | Children | Unknown | None from biosolids | Jamieson et al. 1998 |
| Picobirnavirus | Diarrhea | Adults and children, chickens, rabbits | Unknown | None from biosolids | Cascio et al. 1996; Chandra 1997; Ludert et al. 1995; Gallimore et al. 1995a, 1995b |
| Coxsachieviruses (new serotypes) | Association with diabetes mellitus | Children | Fecal-oral contact | None from biosolids | Roivainen et al. 1998 |
| Small round structured virus (SRSV) | Influenza | Infants, children, elderly | Unknown | None from biosolids | Dedman et al. 1998 |
| Norwalk-like virus (calicivirus) | Unknown | Pigs | Unknown | None from biosolids | Sugieda et al. 1998 |
| Swine HEV (hepatitis E virus in pigs) | Unknown | Pigs | Unknown | None from biosolids | Meng et al. 1998 |
| Torovirus-like particles related to Berne virus, BEV, and Breda virus (BRV) | Gastroenteritis | Humans, horses, and cattle | Unknown | None from biosolids | Duckmanton et al. 1997 |

Table E-19. Other Parasitic Pathogens of Emerging Concern

| Pathogen | Disease | Source | Environmental Sources | Outbreaks Reported | Literature |
|---|---|---|---|---|---|
| Mircrosporidia | Gastroenteritis | Unknown | Unknown | None from biosolids | Johnson and Gerba 1997 |
| Crytosporidium (Genotypes 1 and 2) | Gastroenteritis and diarrhea | Cattle | Unknown, water supply, swimming pools | None from biosolids | Patel et al. 1998, Furtado et al. 1998 |

## Parasitic Microsporidians

Microsporidia are protozoan parasites that can infect humans and cause chronic diarrhea; they are of particular concern because of their being found in patients with AIDS (Johnson and Gerba 1997). They have only recently been discovered (seven species discovered so far) and identified as potential human pathogens, and only recent research indicates that they can be measured in environmental samples (water and wastewater) (Dowd et al. 1998). They are similar to other protozoan parasites such as *Giardia* and *Cryptosporidium* because of their small size, ability to infect different mammals, and spread through the environment; these characteristics, combined with their ability to form spores resistant to heat inactivation and drying, make them a pathogen of emerging concern with a potential to be waterborne (Johnson and Gerba 1997).

## Rotaviruses

Rotaviruses are small RNA viruses that have been found to be associated with gastroenteritis in humans and a wide range of animal species (De Leon and Gerba 1990). It has yet to be shown that animal rotaviruses are pathogenic for man; furthermore, there is no evidence for species cross-infection in nature (Conklin 1981). The human rotavirus has two serotypes. Rotavirus has been associated with as many as 50% of hospitalized cases of diarrheal illness in infants and young children (EOA 1995).

Rotavirus gastroenteritis occurs worldwide both in sporadic and epidemic outbreaks. The primary targets are infants and children, particularly in the 6- to 24-month age group. Cases in adults are relatively infrequent but have been reported, mainly in countries other than the United States (EOA 1995). The most common route of rotavirus transmission is the fecal-oral route, with person-to-person transmission being the most frequent. Most individuals have acquired antibodies to both serotypes of rotavirus by the age of 2 and are therefore protected from the disease as they grow older.

In the United States, rotavirus infections are responsible for 100,000 hospitalizations per year (EOA 1995).

Rotavirus has been isolated from untreated drinking water, treated drinking water, and various foods, but the occurrence of infections from these sources has been rare (De Leon and Gerba 1990). There have been only two occurrences in the United States and these have been traced to improperly treated water (EOA 1995). No cases have been attributed to biosolids.

Rotavirus is persistent in the environment and can survive for as long as 10 days in raw fresh water and as long as 64 days in municipal treated tap water (free chlorine = 0.05 mg/l) (EOA 1995). Rotavirus has been shown to survive more than 14 days in estuarine and heavily polluted fresh water (EOA 1995). Rotavirus can survive as long as 2 weeks on inanimate surfaces, the length of survival depending on relative humidity and temperature (EOA 1995). The length of survival of rotavirus, together with its low infectious dose, leads to concerns over its possible presence in biosolids (Table 5-2 in Chapter 5). No cases of infection have been attributed to biosolids, however.

## Other Viruses

Research continues to reveal the presence of previously unknown viruses that may play an important role in the large number of gastroenteritis cases of unknown origin. Among the new discoveries about which little is known are the human toroviruses (Duckmanton et al. 1997, Koopmans et al. 1997, Jamieson et al. 1998), picobirnaviruses (Gallimore et al. 1995a, 1995b; Chandra 1997), coxsachieviruses, small round structured viruses (SRSV) (Dedman et al. 1998), caliciviruses, Norwalk-like viruses (Sugieda et al. 1998), hepatitis E virus (Meng et al. 1998), Berne and Breda virus (also of animal origin), and adenoviruses. Table E-18 summarizes information on these viruses, their potential sources, and their reporting in scientific literature. Little is known about their transmission, epidemiology, environmental fate, or presence in biosolids or wastewater. However, their reporting is noted here as an indication that new pathogens continue to be discovered and that constant assessment of existing management practices is needed to ensure that biosolids are not contributing to the spread of disease. To date, no evidence indicates that they are.

Picobirnaviruses are a novel group of viruses recently found in the feces of several species of vertebrates. They have been detected in the feces of humans suffering from cryptosporidiosis and, although they have not been associated with any outbreaks attributable to water or food, are a pathogen of emerging concern. The prevalence of picnovirus in those studied in the United Kingdom was found to be 9%-13% in a wide range of patients (ages 3 to more than 65) in those both with and without the symptom of gastroentiritis (Gallimore et al. 1995b). No outbreaks caused by these viruses have been reported in the United States.

Toroviruses alone or in combination with enteroaggregative *E. coli* may play a pathogenic role in acute and possibly persistent diarrhea in children. Further studies are warranted to determine the etiologic role of toroviruses in gastroenteritis.

## Other Diseases

### Bovine Spongiform Encephalopathy

Well-publicized news reports in 1996 suggested that consumption of beef from diseased cattle in Britain may have caused a fatal human brain disease (Floyd 1996, Pattison 1998). The condition in the British cattle, commonly referred to as "mad cow disease" in these reports, is a disease called bovine spongiform encephalopathy, or BSE. Cattle with BSE have a degenerative brain condition that develops slowly over a 2- to 8-year period. BSE is similar in its effects on the cattle brain to other spongiform encephalopathy (SE) diseases in the brains of other animals. These include Kuru and Creutzfeldt-Jacob disease (CJD) in humans, scrapie in sheep, transmissible mink encephalopathy (TME), chronic wasting disease of mule deer and elk, feline spongiform encephalopathy (FSE), and a few others. Experimental studies have demonstrated that animals can contract some of the SE diseases by ingesting nervous system tissues (brain, spinal cord, etc.) from affected animals. It is suspected (although there is still much debate) that the causative agent in the SE diseases may be a prion, or a filterable glycoprotein devoid of detectable nucleic acid that is resistant to typical means of sterilization (Pattison 1998). These agents have survived 3 years of burial in outside soil and heating to high temperatures. An unidentified virus is also theorized as a cause.

BSE was first seen and diagnosed in Britain in 1986. It may have arisen as a result of rendered sheep byproducts being fed to cattle as protein supplements. Some of these sheep may have been infected with scrapie, an SE disease that has been known for more than 200 years. The number of BSE cases increased to a peak of about 1,000 new cases per weak by January 1993 and then began to decrease. The epidemic may have worsened because initially it was possible for cattle that had been affected with BSE to be rendered into protein supplements for other cattle. The British government banned feeding of ruminant-derived animal proteins to other ruminants in 1989. Because of the 2- to 8-year "incubation" period of development of BSE, cases continued to occur after this ban went into effect. In any event, the number of cases has decreased significantly and continues to decrease as a result of regulatory interventions, such as the offal feeding ban, which is now effectively applied.

Muscle tissue and milk have not been demonstrated to transmit BSE, but brain and spinal cord tissue have. Therefore, steps taken in Britain to ensure that nervous tissues from cattle do not enter the human food supply should effectively prevent any transmission; it is unknown whether such transmission ever actually occurred. These steps also have been taken in the United States.

To prevent the possibility of BSE entering the country, in 1989 the United States banned imports of live cattle and zoo ruminants from the United Kingdom and any country with BSE; imports of sheep and goats from the United Kingdom had already been banned because of scrapie.

No case of BSE has been diagnosed in the United States, despite aggressive efforts on the part of the U.S. Department of Agriculture and other surveillance programs for BSE. Included in the search are examinations at the National Services Veterinary Laboratory of the brains of cattle diagnosed with nervous system disease (postmortem microscopic examination of brain tissue) and periodic examinations of all live cattle in the United States that came from the United Kingdom before the import ban was instituted.

No research has been conducted to measure the presence of prions in the environment and there are no known means of measurement. Gale (1998) assessed the likelihood of prions being a risk if water from an aquifer were contaminated by a cattle-rendering plant discharging effluent to the aquifer, and found the risk of infection to be in the range of 1 in 100 million to 1 in 1 billion. Because the disease is not present in the United States, such an analysis provides further assurance that this disease represents a minimal threat to public health.

## Part 2. EPA Part 503 Risk Assessment for the Land Application of Sewage Sludge

The EPA conducted extensive risk assessments for application of sewage sludge onto agricultural land and nonagricultural land (i.e., forest land, reclamation !and, and public contact sites). These assessments, based on a number of different exposure pathways and various "worst-case" (highly exposed individual or HEI) exposure assumptions, formed the basis for the sewage sludge pollutant loading limits specified in Section 503.13 of 40 CFR Part 503 Standards for the Use or Disposal of Sewage Sludge and used as minimum requirements in the SWRCB General Order (GO). The risk assessments and all the calculations and assumptions used are described in detail in technical support documents (U. S. Environmental Protection Agency 1992, Volumes 1 and 2).

Risk assessments were conducted for 14 exposure pathways for agricultural land and 12 exposure pathways for nonagricultural land. Pathway 2, human toxicity from ingesting plants grown in the home garden, and pathway 11, human exposure through inhalation of particulates resuspended by tilling of sewage sludge, were not analyzed for nonagricultural application because these are not appropriate exposure scenarios for nonagricultural land. These pathways are described in Table E-20.

The EPA assembled a national peer review committee of 35 recognized academic, government, and private industry experts in the field of sludge application to land for 10 of the risk assessments (pathways 1-10). This committee critically evaluated the methodology

and data used to assess risk as part of developing criteria for land application of potentially toxic chemicals in municipal sewage sludge. The EPA's Office of Water conducted the risk assessment for pathway 11. The risk assessments for pathways 12, 13, and 14 were conducted for the EPA by the consulting firm ABT Associates (ABT Associates 1993).

Charles Henry of the University of Washington conducted thc risk assessments for pathways 1 through 10 for nonagricultural land (except for pathway 2 for home gardening). Pathways 12, 13, and 14 are identical for agricultural and nonagricultural land, so ABT Associates' assessment of agricultural pathways 12, 13, and 14 was also used for the nonagricultural pathways (U.S. Environmental Protection Agency 1992).

In undertaking the assessments, the EPA relied on numerous assumptions and decisions regarding the data to be used and what the exposure evaluations were to be based on. It was decided to use the concept of the highly exposed individual (HEI) as a target organism to be protected by the limits on individual pollutants. Depending on the pathway of exposure, the HEI could be a human, plant, animal, or environmental end point, such as surface water or groundwater, and is assumed to remain for an extended period at or adjacent to the site where the maximum exposure occurs.

Table E-20. Environmental Pathways of Concern
Identified for Application of Sewage Sludge to Agricultural Land

| Pathway | Description of Highly Exposed Individual |
|---|---|
| 1. Sewage Sludge-Soil-Plant-Human | Human ingesting plants grown in sewage sludge-amended soil |
| 2. Sewage Sludge-Soil-Plant-Human | Residential home gardener |
| 3. Sewage Sludge-Human | Children ingesting sewage sludges |
| 4. Sewage Sludge-Soil-Plant-Animal-Human | Farm households producing a major portion of the animal products they consume; it is assumed that the animals eat plants grown in soil amended with sewage sludge |
| 5. Sewage Sludge-Soil-Animal-Human | Farm households consuming livestock that ingest sewage sludge while grazing |
| 6. Sewage Sludge-Soil-Plant-Animal | Livestock ingesting crops grown on sewage sludge-amended soil |
| 7. Sewage Sludge-Soil-Animal | Grazing livestock ingesting sewage sludge |
| 8. Sewage Sludge-Soil-Plant | Plants grown in sewage sludge-amended soil |

| Pathway | Description of Highly Exposed Individual |
|---|---|
| 9. Sewage Sludge-Soil-Soil Organism | Soil organisms living in sewage sludge-amended soil |
| 10. Sewage Sludge-Soil-Soil Organism-Soil Organism Predator | Animals eating soil organisms living in sewage sludge-amended soil |
| 11. Sewage Sludge-Soil-Airborne Dust-Human | Tractor operator exposed to dust while plowing large areas of sewage sludge-amended soil |
| 12. Sewage Sludge-Soil-Surface Water-Human | Person who consumes 0.04 kg/day of fish and 2 liters/day of water. |
| 13. Sewage Sludge-Soil-Air-Human | Human breathing volatile pollutants from sewage sludge |
| 14. Sewage Sludge-Soil-Groundwater-Human | Human drinking water from wells contaminated with pollutants leaching from sewage sludge-amended soil to groundwater |

The risk-based models developed for the Part 503 regulations were designed to limit potential exposure of an HEI. Originally, in the 1989 proposed Part 503 rule, the concept for "worst-case" exposure was based on the "most exposed individual" (MEI), but the EPA changed this to be consistent with a statement in the rule's legislative history that calls for protecting individuals and populations that are "highly exposed to reasonably anticipated adverse conditions". In developing Subpart B of the rule, the EPA used different HEIs in evaluating each pathway of potential exposure.

The details for each of the HEIs selected and the assumptions used in the various risk scenario calculations are all contained in the technical support documents, which are voluminous (U. S. Environmental Protection Agency 1992). Examples are given here to provide an illustration of the HEIs for both the agricultural and nonagricultural settings for pathway 1, which was designed to protect consumers who eat food grown in sewage sludge-amended soil. For agricultural land application, the HEI was assumed to live in a region where a relatively high percentage of the available cropland receives sludge applications. To approximate realistic conditions, it was assumed that the HEI eats a mix of crops from land on which sludge was applied and crops from land on which sludge was not applied rather than eating foods that were all grown on sludge-amended soils.

For nonagricultural settings for pathway 1, the HEI was a person who regularly harvests edible wild plants (i.e., berries and mushrooms) from forests or rangelands that have been amended with sewage sludge. This food was assumed to be preserved by drying, freezing,

or canning and, hence, to be available for consumption throughout the year. It was also assumed that an individual could continue with this practice for a lifetime (70 years).

Pathway 2 evaluated the effects on home gardeners of consuming crops grown in residential home gardens amended with sewage sludge. The major difference between pathways 1 and 2 was the fraction of food assumed to be grown on sewage sludge-amended soil. The HEI for pathway 2 was the home gardener who produced and consumed potatoes, leafy vegetables, fresh legumes, root vegetables, garden fruits (e.g., tomatoes, eggplants), sweet corn, and grains.

The HEI for pathway 3 was a young person (less than 6 year of age) ingesting sewage sludge from storage piles or from the soil surface.

For pathway 4, the HEI was an individual consuming foraging animals that consumed feed crops or vegetation grown on sewage sludge-amended soils. The HEI was assumed to consume daily quantities of the various animal tissue foods and to be exposed to background levels of pollutants from sources other than sludge. For the agricultural setting, the affected animal foods evaluated were beef, beef liver, lamb, pork, poultry, dairy, and eggs. In the nonagricultural setting, the HEI was assumed to be a hunter who preserved meat (including liver) for consumption throughout the year. The animals were assumed to have been hunted in the forest and eaten were deer and elk (because of their size and greater possibility of impact on intake through consumption compared with other animals).

Pathway 5 involved the application of sewage sludge to the land; the direct ingestion of this sewage sludge by animals; and, finally, the consumption of contaminated animal tissue by humans. The HEI was assumed to consume various animal tissue foods and be exposed to a background intake of pollutants.

Pathway 6 evaluated animals that ingest plants grown on sewage sludge-amended soil. The HEI used for both the agricultural and nonagricultural settings is a highly sensitive herbivore that consumed plants grown on sewage sludge-amended soil. Background intake was taken into account by considering background concentration of pollutants in forage crops. In a forest application site, the HEI was two grazing domestic animals and small herbivorous mammals (deer mice) that lived their entire lives in a sewage sludge-amended area feeding on seeds and small plants close to the layer of soil amended with sewage sludge. In the agricultural setting, the HEI was a sheep.

The HEI for pathway 7 was an herbivorous animal incidentally consuming sewage sludge adhering to forage crops and/or sewage sludge on the soil surface. Background intake was considered to be from ingesting soil having background levels of pollutant. Because forest animals more typically browse rather than graze, the HEI for agricultural settings was used as a reasonable worst-case surrogate for the nonagricultural HEI.

Pathway 8 was the plant phytotoxicity pathway and assumed as the HEI a plant sensitive to the pollutants in sewage sludge. Sensitivity was determined through a literature search including information on nonagronomic species, which were shown to be no more sensitive

than agronomic species. Because sensitivity was found to be the same for agronomic and nonagronomic species, the limits set for agricultural species also protect wild species found in nonagricultural settings.

The HEI for pathway 9 is a soil organism sensitive to the pollutants in sewage sludge, an earthworm. Because all soil organisms are wild species, the same HEI was used for the nonagricultural and agricultural settings.

Pathway 10 assumed that the HEI was a shrew mole that consumed soil organisms that have been feeding on sewage sludge-amended soil. Pathway 9 had the same HEI for both the nonagricultural and agricultural pathways.

The HEI for pathway 11, which was designed to protect humans from the effects of airborne dusts containing sewage sludge, was a tractor driver tilling a field. This pathway evaluated the impact of particles that have been resuspended by the driver's tilling of dewatered sewage sludge into the soil. This pathway applies only to the agricultural setting because plowing is not normally performed in nonagricultural settings such as forests.

Pathway 12, the soil erosion pathway, used as an HEI a human who consumed 2 liters per day of drinking water from surface water contaminated by soil eroded from a site where sewage sludge was land applied. This individual was assumed to ingest 0.04 kilograms per day of fish from surface waters contaminated by sewage sludge pollutants. The HEI was the same for agricultural and nonagricultural practices.

Pathway 13 had as an HEI a human who inhaled the vapors of any volatile pollutants that may be in the sewage sludge when it is applied to the land. The HEI was assumed to live on the downwind side of the site with no change in wind direction ever occurring (constant exposure). The same plume air contaminant dispersion model was used for both the agricultural and nonagricultural settings.

The HEI for pathway 14 for agricultural and nonagricultural settings was an individual who obtained drinking water from ground water located directly below a field to which sewage sludge has been applied. Consumption was assumed to be 2 liters per day for a lifetime.

All the exposure scenarios involving ingestions included what is referred to as an oral reference dose (RfD). The RfD of a pollutant is a threshold below which effects adverse to human health are unlikely to occur. The EPA has a computerized listing of these human health criteria in its Integrated Risk Information System (IRIS), which it uses for many different purposes in developing health protection standards based on the latest scientific information.

Another key assumption that can change the risk assumption calculations is the recommended dietary allowances (RDAs). These are defined as the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons. Although RfDs were generally used to determine the concentrations of inorganic

pollutants that are protective of human health, the RDA was used in the case of zinc and copper.

# Part 3. Endocrine Disruptors

## Introduction

A wide range of chemicals, including some in common, often unregulated, undisclosed use are now associated with effects on the health, reproduction, and behavior of animals. At present, many of the effects are nonspecific in terms of the link to a particular environmental chemical, but the trends in research on hormone-affecting diseases indicate that it is probable that endocrine disruptors are contributing to human diseases and dysfunction.

The EPA has been directed by Congress to look into the issue of endocrine disruptors, focusing first on transmission in drinking water. An interagency task force of national experts has been assembled and a research plan has been developed.

Compounds termed "endocrine disruptors" can include both natural compounds and synthetic chemicals. Some, called phytoestrogens, occur naturally in a variety of plants; animals have evolved mechanisms to metabolize these, and they therefore do not accumulate and have adverse effects. A number of compounds that act as synthetic estrogens are now produced either through industrial manufacture (pesticides) or as byproducts of such processes or burning (such as dioxins). Testing for estrogenic activity is conducted in the lab using cultures of breast cancer cells. It has been found that some chemicals can cause effects at levels of parts per trillion—levels at which most chemicals have never been tested.

Table E-21 lists a variety of suspected hormone disruptors, which are discussed below.

Table E-21. List of Known and Suspected Hormone Disruptors:
Pollutants with Widespread Distribution Reported to Have Reproductive and Endocrine-Disrupting Effects

| Persistent Organohalogens | Pesticides |
|---|---|
| Dioxins and furans | 2,4,5-T |
| PCBs | 2,4-D |
| PBBs | alachlor |
| Octachlorostyrene | aldicarb |
| Hexachlorobenzene | amitrole |
| Pentachlorophenol | atrazine |

benomyl
beta-HCH
carbaryl
chlordane
cypermethrin
DBCP
DDT
DDT metabolites
dicofol
dieldrin
endosulfan
esfenvalerate
ethylparathion
fenvalerate
lindane
heptachlor
h-epoxide
kelthane
kepone
malathion
mancozeb
maneb
methomyl
methoxychlor
metiram
metribuzin
mirex
nitrofen
oxychlordane
permethrin
synthetic pyrethroids
toxaphene
transnonachlor
tributyltin oxide
trifluralin
vinclozolin
zineb
ziram

Phenolic Compounds
Penta- to Nonyl-Phenols
Bisphenol A

Phthalates
Di-ethylhexyl phthalate (DEHP)
Butyl benzyl phthalate (BBP)
Di-n-butyl phthalate (DBP)
Di-n-pentyl phthalate (DPP)Di-hexyl phthalate (DHP)
Di-propyl phthalate (DprP)
Dicyclohexyl phthalate (DCHP)
Diethyl phthalate (DEP)

Other Organics
Styrene dimers and trimers
Benzo(a)pyrene

Heavy Metals
Cadmium
Lead
Mercury

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Source: Natural Resources Defense Council Endocrine Disruptors Web Page (www.nroc.org/nrdc/nrdc/proreports.html).

## Pesticides

Many pesticides have been found to be estrogenic. These include the herbicides 2,4-D and 2,4,-T and the boat-fouling paint additive tributyl tin, and the traditional pesticides used widely in the past, such as carbaryl, chlordane, DDT, lindane, malathion, parathion, aldicarb, DBCP, and synthetic pyrethroids. Exposure can occur during application, through consumption of contaminated produce and other foods, through contaminated drinking water, or even from house dust in agricultural areas. Production of DDT for use in the United States was banned in 1972. However, other countries, especially tropical countries such as Mexico, still use it for mosquito control to combat malaria. DDT and its metabolites bioaccumulate in wildlife, and humans can be exposed through the food chain.

## Soaps, Shampoos, and Hair Colors

Many industrial and consumer products contain alkylphenol ethoxylates (APEs), which break down into alkylphenols such as nonylphenol, which has been found in sewage and rivers near outfalls. One of the main uses of these compounds is in liquid detergents. In Europe, these products have been replaced by the more expensive but much safer alcohol ethoxylates. Denmark based its phaseout of alkyphenol exthoxylate on research conducted in the United Kingdom, which found that its breakdown products, alkylphenols, caused male fish to take on female characteristics. Alkylphenols do not biodegrade easily and bioaccumulate and therefore may cause problems when sewage sludge is applied to land.

## Plastics and Plasticizers

Plastics contain additives, such as phthalates, bisphenol-A, and nonylphenols, usually present as plasticizers to increase flexibility and durability. They can leach out into liquids and foods. Heating speeds up this leaching process, which is why microwaving of foods in plastic is discouraged. Estrogenic butyl benzyl phthalate is found in vinyl floor tiles, adhesives, and synthetic leathers. The related compound di-butyl phthalate is present in some food-contact papers. Bisphenol-A is a breakdown product of polycarbonate plastics, which are used in water bottles, baby bottles, and the linings of some food cans.

## Polychlorinated Biphenyls (PCBs)

PCBs are a family of toxic industrial chemicals commercialized in 1929 by Monsanto. Although their production in the United States stopped in 1977, world production continued. PCBs are still present in the United States in electrical equipment and are frequently found at toxic waste sites and in contaminated sediments. A recent study confirmed that children exposed to low levels of PCBs in the womb because of their mother's fish consumption grow up with low IQs, poor reading comprehension, difficulty paying attention, and memory problems.

## Dioxins

Chlorinated dioxins and dibenzofurans are byproducts of the chlorine bleaching of paper; the burning of chlorinated hydrocarbons such as pentachlorophenol, PCBs, and polyvinyl chloride; the incineration of municipal and medical wastes; and natural events, such as forest fires and volcanic eruptions. They often contaminate toxic wastes sites, especially where there have been fires. They bioaccumulate in fish and other wildlife, and the most common human route of exposure is through the food chain.

## Spermicides

Many spermicides contain nonoxynol-9, a nonylphenol that kills sperm. This compound can be carried into the sewer system and hence into biosolids, although the concentrations are probably not measurable.

## Preservatives

BHA, butylated hydroxyanisole, is added to foods such as breakfast cereal, or its packaging, to prevent the foods from becoming rancid.

## Metals

Lead, methyl mercury, and cadmium can disrupt the endocrine system by causing problems in steroid production.

In addition, a number of other pollutants with widespread distribution in the environment are reported to bind to hormone receptors and therefore are suspected to have reproductive and endocrine-disrupting effects. These pollutants include the following:

- 2,4-dichlorophenol
- diethylhexyl adipate
- benzophenone
- N-butyl benzene
- 4-nitrotoluene

The compounds listed above are only suspected of being endocrine disruptors. All of these compounds have had wide uses in the past and are present in the environment, although only a few are likely to be found. Their presence in biosolids, soils, water, food, or animals is variable and depends on the historical use of the chemicals and the means of environmental distribution. At present, there is no evidence that their presence in biosolids would increase health risks.

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Gerba, Charles, Ph.D. Professor. University of Arizona, Phoenix, AZ. February 16, 1999 - telephone communication.

Shaw, Guy. Environmental health specialist. Kern County Health Department, Bakersfield, CA. February 3, 1999 - telephone conversation and facsimile transmission.

Starr, Dr. Mark. California Department of Health Services Disease Investigations & Surveillance Branch, Surveillance & Statistics Section. February 2, 1999 - telephone conversation and electronic data transmittal.

Table E-1a Reported Incidence of Enterotoxic E coli O157 in California (1992-1998)

| Local Health Department | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| ALAMEDA | | 3 | 12 | 11 | 16 | 14 | 28 |
| AMADOR | | | | 3 | | 2 | |
| BERKELEY | | 1 | 3 | | | | 1 |
| BUTTE | | | | 2 | 1 | 6 | 1 |
| CALAVERAS | | | | | | 2 | 2 |
| COLUSA | | | | 1 | | | |
| CONTRA COSTA | | | 1 | | 4 | 8 | 14 |
| EL DORADO | | | | 2 | | 1 | 3 |
| FRESNO | | 1 | 6 | 10 | 4 | 3 | 4 |
| GLENN | | | 1 | | | 1 | |
| HUMBOLDT | | | 1 | | 9 | 3 | 5 |
| IMPERIAL | | | | | | | 2 |
| INYO | | | 2 | | | | |
| KERN | | | | 1 | 2 | | 3 |
| KINGS | | | | | 2 | 1 | |
| LONG BEACH (City) | | | | 1 | 4 | 1 | |
| LOS ANGELES | | 9 | 13 | 6 | 18 | 20 | 24 |
| MADERA | | | 1 | | 1 | 3 | 1 |
| MARIN | | | 1 | 1 | 8 | 3 | 5 |
| MENDOCINO | | | 1 | | 2 | 1 | 2 |
| MERCED | | | | 1 | 1 | | 4 |
| MODOC | | 1 | | | | | |
| MONO | | 1 | 1 | | | | |
| MONTEREY | | 2 | 1 | 1 | 3 | 2 | 2 |
| NAPA | | | | | 3 | 2 | 4 |
| NEVADA | | | | 1 | 1 | 1 | 1 |
| ORANGE | | 6 | 1 | 6 | 6 | 6 | 11 |
| PASADENA (City) | | | | | 2 | | |
| PLACER | | | | 3 | 3 | 4 | 3 |
| PLUMAS | | | | | 1 | | |
| RIVERSIDE | | 1 | 1 | 2 | | 4 | 2 |
| SACRAMENTO | | 2 | 7 | 10 | 18 | 8 | 16 |
| SAN BENITO | | 1 | | 1 | 3 | | |
| SAN BERNARDINO | | 2 | 2 | 2 | | 5 | 1 |
| SAN DIEGO | 1 | 26 | 17 | 12 | 15 | 15 | 24 |
| SAN FRANCISCO | | 4 | 4 | 2 | 5 | 1 | 12 |
| SAN JOAQUIN | | 1 | 14 | 6 | 10 | 7 | 14 |
| SAN LUIS OBISPO | | 3 | 5 | 5 | 2 | 4 | 2 |
| SAN MATEO | | 1 | 7 | | 5 | 11 | 19 |
| SANTA BARBARA | | 2 | 2 | 8 | 3 | 3 | 6 |
| SANTA CLARA | | 9 | 7 | 4 | 15 | 11 | 19 |
| SANTA CRUZ | | | 2 | 1 | 6 | 2 | 5 |
| SHASTA | | | | | | 1 | |
| SISKIYOU | | | 1 | | | | 1 |
| SOLANO | | | | 1 | 1 | 3 | 2 |
| SONOMA | | 1 | | 3 | 5 | 4 | 9 |
| STANISLAUS | | 3 | | 4 | | 8 | 5 |
| TULARE | | | | 3 | 2 | 2 | |
| TUOLUMNE | | | | | | 1 | 5 |
| VENTURA | | | 4 | | | 6 | 2 |
| YOLO | | | | 4 | 1 | 1 | |
| YUBA | | | | | 4 | | |
| Grand Total | 1 | 80 | 118 | 118 | 186 | 181 | 264 |

Table E-1b Reported Incidence of Enterotoxic E coli O157 in California (1992-1998)

| | Disease Incidence/100,000 by Year | | | | | | |
|---|---|---|---|---|---|---|---|
| Local Health Department | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 0.0 | 0.2 | 1.0 | 0.9 | 1.3 | 1.1 | 2.1 |
| AMADOR | 0.0 | 0.0 | 0.0 | 9.2 | 0.0 | 6.0 | 0.0 |
| **BERKELEY (City)** | 0.0 | 1.0 | 2.9 | 0.0 | 0.0 | 0.0 | 0.9 |
| BUTTE | 0.0 | 0.0 | 0.0 | 1.0 | 0.5 | 3.0 | 0.5 |
| CALAVERAS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.4 | 5.2 |
| COLUSA | 0.0 | 0.0 | 0.0 | 5.6 | 0.0 | 0.0 | 0.0 |
| CONTRA COSTA | 0.0 | 0.0 | 0.1 | 0.0 | 0.5 | 0.9 | 1.5 |
| EL DORADO | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.7 | 2.0 |
| FRESNO | 0.0 | 0.1 | 0.8 | 1.3 | 0.5 | 0.4 | 0.5 |
| GLENN | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 3.7 | 0.0 |
| HUMBOLDT | 0.0 | 0.0 | 0.8 | 0.0 | 7.2 | 2.4 | 4.0 |
| IMPERIAL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 |
| INYO | 0.0 | 0.0 | 10.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| KERN | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 | 0.0 | 0.5 |
| KINGS | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 0.9 | 0.0 |
| **LONG BEACH (City)** | 0.0 | 0.0 | 0.0 | 0.2 | 0.9 | 0.2 | 0.0 |
| LOS ANGELES | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 |
| MADERA | 0.0 | 0.0 | 1.0 | 0.0 | 0.9 | 2.7 | 0.9 |
| MARIN | 0.0 | 0.0 | 0.4 | 0.4 | 3.3 | 1.2 | 2.0 |
| MENDOCINO | 0.0 | 0.0 | 1.2 | 0.0 | 2.4 | 1.2 | 2.3 |
| MERCED | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.0 | 2.0 |
| MODOC | 0.0 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MONO | 0.0 | 9.8 | 9.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| MONTEREY | 0.0 | 0.5 | 0.3 | 0.3 | 0.8 | 0.5 | 0.5 |
| NAPA | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 1.7 | 3.3 |
| NEVADA | 0.0 | 0.0 | 0.0 | 1.2 | 1.2 | 1.1 | 1.1 |
| ORANGE | 0.0 | 0.2 | 0.0 | 0.2 | 0.2 | 0.2 | 0.4 |
| **PASADENA (City)** | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 |
| PLACER | 0.0 | 0.0 | 0.0 | 1.5 | 1.5 | 1.9 | 1.4 |
| PLUMAS | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 | 0.0 | 0.0 |
| RIVERSIDE | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.3 | 0.1 |
| SACRAMENTO | 0.0 | 0.2 | 0.6 | 0.9 | 1.6 | 0.7 | 1.4 |
| SAN BENITO | 0.0 | 2.5 | 0.0 | 2.4 | 6.9 | 0.0 | 0.0 |
| SAN BERNARDINO | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.3 | 0.1 |
| SAN DIEGO | 0.04 | 1.0 | 0.6 | 0.5 | 0.6 | 0.5 | 0.9 |
| SAN FRANCISCO | 0.0 | 0.5 | 0.5 | 0.3 | 0.7 | 0.1 | 1.5 |
| SAN JOAQUIN | 0.0 | 0.2 | 2.7 | 1.2 | 1.9 | 1.3 | 2.6 |
| SAN LUIS OBISPO | 0.0 | 1.3 | 2.2 | 2.2 | 0.9 | 1.7 | 0.8 |
| SAN MATEO | 0.0 | 0.1 | 1.0 | 0.0 | 0.7 | 1.6 | 2.7 |
| SANTA BARBARA | 0.0 | 0.5 | 0.5 | 2.1 | 0.8 | 0.8 | 1.5 |
| SANTA CLARA | 0.0 | 0.6 | 0.4 | 0.3 | 0.9 | 0.7 | 1.1 |
| SANTA CRUZ | 0.0 | 0.0 | 0.8 | 0.4 | 2.5 | 0.8 | 2.0 |
| SHASTA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 |
| SISKIYOU | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 2.3 |
| SOLANO | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 0.8 | 0.5 |
| SONOMA | 0.0 | 0.2 | 0.0 | 0.7 | 1.2 | 0.9 | 2.1 |
| STANISLAUS | 0.0 | 0.7 | 0.0 | 1.0 | 0.0 | 1.9 | 1.2 |
| TULARE | 0.0 | 0.0 | 0.0 | 0.9 | 0.6 | 0.6 | 0.0 |
| TUOLUMNE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 9.5 |
| VENTURA | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.8 | 0.3 |
| YOLO | 0.0 | 0.0 | 0.0 | 2.7 | 0.7 | 0.7 | 0.0 |
| YUBA | 0.0 | 0.0 | 0.0 | 0.0 | 6.5 | 0.0 | 0.0 |

Table E-2a  Reported Incidence of Campylobacter in California (1990-1998)

| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| ALAMEDA | 319 | 375 | 365 | 395 | 515 | 380 | 537 | 450 | 346 |
| ALPINE | | | | 1 | | | | 1 | |
| AMADOR | 5 | 4 | 8 | 2 | 15 | 6 | 12 | 6 | 13 |
| BERKELEY | 64 | 86 | 56 | 68 | 61 | 74 | 110 | 83 | 61 |
| BUTTE | 24 | 36 | 26 | 34 | 58 | 58 | 38 | 72 | 54 |
| CALAVERAS | 6 | 3 | 3 | 6 | 8 | 8 | 11 | 9 | 7 |
| COLUSA | 2 | | | | 3 | 3 | 2 | 6 | 1 |
| CONTRA COSTA | 342 | 380 | 275 | 357 | 430 | 344 | 313 | 322 | 188 |
| DEL NORTE | 2 | 6 | 7 | 2 | 4 | 3 | 4 | 1 | 4 |
| EL DORADO | 9 | 6 | 10 | 8 | 11 | 10 | 15 | 12 | 10 |
| FRESNO | 101 | 183 | 184 | 186 | 199 | 231 | 181 | 182 | 225 |
| GLENN | 4 | 2 | 2 | 5 | 4 | 6 | 4 | 8 | 6 |
| HUMBOLDT | 20 | 26 | 29 | 57 | 48 | 47 | 36 | 38 | 32 |
| IMPERIAL | | 3 | 1 | 3 | 25 | 20 | 19 | 19 | 23 |
| INYO | 6 | 9 | 8 | 3 | 6 | 4 | 6 | 2 | 5 |
| KERN | 52 | 106 | 132 | 86 | 101 | 131 | 164 | 150 | 173 |
| KINGS | 1 | 2 | 2 | 12 | 18 | 24 | 13 | 25 | 18 |
| LAKE | 3 | | 5 | 4 | 4 | 4 | 11 | 4 | 3 |
| LASSEN | 2 | 6 | 1 | 1 | 4 | 3 | 4 | 2 | 2 |
| LONG BEACH | 79 | 84 | 89 | 73 | 61 | 56 | 93 | 92 | 67 |
| LOS ANGELES | 1193 | 1251 | 1432 | 1417 | 1350 | 1249 | 1752 | 1606 | 1236 |
| MADERA | 13 | 3 | 28 | 26 | 32 | 17 | 36 | 32 | 35 |
| MARIN | 66 | 237 | 214 | 135 | 138 | 186 | 167 | 128 | 71 |
| MARIPOSA | 1 | 3 | 3 | 1 | 4 | 2 | 3 | 1 | 1 |
| MENDOCINO | 17 | 11 | 14 | 20 | 12 | 32 | 26 | 30 | 21 |
| MERCED | 28 | 73 | 68 | 64 | 93 | 76 | 95 | 81 | 40 |
| MODOC | | 1 | 2 | | | | | | 3 |
| MONO | 2 | 2 | 1 | 3 | 11 | | 3 | 1 | |
| MONTEREY | 93 | 107 | 79 | 95 | 100 | 83 | 94 | 85 | 67 |
| NAPA | 56 | 60 | 79 | 68 | 70 | 63 | 66 | 73 | 44 |
| NEVADA | 6 | 21 | 13 | 17 | 10 | 11 | 21 | 14 | 7 |
| ORANGE | 338 | 303 | 308 | 340 | 193 | 445 | 447 | 403 | 284 |
| PASADENA | 22 | 28 | 32 | 22 | 37 | 24 | 17 | 23 | 26 |
| PLACER | 29 | 32 | 43 | 51 | 35 | 21 | 39 | 60 | 37 |
| PLUMAS | 3 | 7 | 5 | 4 | 4 | 6 | 2 | 4 | |
| RIVERSIDE | 133 | 128 | 186 | 174 | 151 | 129 | 210 | 217 | 136 |
| SACRAMENTO | 256 | 375 | 240 | 147 | 254 | 106 | 86 | 137 | 156 |
| SAN BENITO | 4 | 9 | 10 | 15 | 21 | 18 | 18 | 7 | 9 |
| SAN BERNARDINO | 80 | 107 | 117 | 148 | 181 | 193 | 243 | 227 | 162 |
| SAN DIEGO | 444 | 471 | 547 | 566 | 881 | 715 | 697 | 540 | 465 |
| SAN FRANCISCO | 774 | 714 | 711 | 625 | 614 | 560 | 603 | 584 | 427 |
| SAN JOAQUIN | 246 | 255 | 225 | 228 | 213 | 202 | 233 | 212 | 156 |
| SAN LUIS OBISPO | 31 | 36 | 40 | 53 | 52 | 53 | 61 | 61 | 34 |
| SAN MATEO | 304 | 389 | 370 | 383 | 461 | 382 | 340 | 344 | 291 |
| SANTA BARBARA | 57 | 67 | 100 | 83 | 84 | 66 | 58 | 71 | 70 |
| SANTA CLARA | 392 | 435 | 473 | 561 | 578 | 500 | 431 | 420 | 327 |
| SANTA CRUZ | 52 | 53 | 28 | 109 | 100 | 91 | 100 | 108 | 73 |
| SHASTA | 24 | 11 | 12 | 18 | 39 | 22 | 9 | 18 | 20 |
| SIERRA | | | 2 | 2 | 3 | 1 | 1 | 2 | 1 |
| SISKIYOU | 7 | 8 | 8 | 14 | 15 | 11 | 13 | 2 | 7 |
| SOLANO | 69 | 86 | 93 | 109 | 128 | 98 | 110 | 104 | 74 |
| SONOMA | 98 | 102 | 152 | 227 | 171 | 147 | 170 | 165 | 137 |
| STANISLAUS | 88 | 93 | 92 | 119 | 166 | 137 | 143 | 143 | 158 |
| SUTTER | 12 | 12 | 8 | 14 | 19 | 18 | 19 | 13 | 13 |
| TEHAMA | 1 | 2 | 4 | 6 | 6 | 2 | 2 | 6 | 6 |
| TRINITY | | 2 | | 5 | 2 | 1 | 3 | | 2 |
| TULARE | 66 | 51 | 59 | 61 | 101 | 96 | 115 | 99 | 96 |
| TUOLUMNE | 2 | 3 | 2 | 8 | 5 | 4 | 7 | 4 | 7 |
| VENTURA | 73 | 85 | 86 | 131 | 127 | 119 | 133 | 117 | 78 |
| YOLO | 52 | 39 | 43 | 44 | 40 | 48 | 64 | 41 | 63 |
| YUBA | 7 | 9 | 9 | 14 | 9 | 16 | 10 | 10 | 7 |
| Grand Total | 6196 | 6998 | 7141 | 7430 | 8085 | 7362 | 8220 | 7677 | 6085 |

Table E-2b  Reported Incidence of Campylobacter in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 27.2 | 31.5 | 30.3 | 32.3 | 41.7 | 30.7 | 42.9 | 35.3 | 26.5 |
| ALPINE | 0.0 | 0.0 | 0.0 | 88.5 | 0.0 | 0.0 | 0.0 | 84.0 | 0.0 |
| AMADOR | 16.6 | 13.0 | 25.4 | 6.3 | 46.3 | 18.5 | 36.6 | 18.1 | 39.0 |
| **BERKELEY** | 62.3 | 83.3 | 53.7 | 65.3 | 58.5 | 70.8 | 105.1 | 78.1 | 56.4 |
| BUTTE | 13.2 | 19.5 | 13.8 | 17.9 | 30.1 | 29.8 | 19.4 | 36.5 | 27.1 |
| CALAVERAS | 18.8 | 9.1 | 8.7 | 17.0 | 22.2 | 21.9 | 29.8 | 24.3 | 18.4 |
| COLUSA | 12.3 | 0.0 | 0.0 | 0.0 | 17.1 | 16.9 | 11.1 | 32.6 | 5.4 |
| CONTRA COSTA | 42.6 | 46.6 | 33.2 | 42.3 | 50.2 | 39.8 | 35.9 | 36.3 | 20.7 |
| DEL NORTE | 8.5 | 23.8 | 26.4 | 7.4 | 14.6 | 10.9 | 14.5 | 3.6 | 14.2 |
| EL DORADO | 7.1 | 4.6 | 7.5 | 5.8 | 7.8 | 7.0 | 10.4 | 8.3 | 6.7 |
| FRESNO | 15.1 | 26.7 | 26.1 | 25.7 | 27.1 | 30.9 | 23.8 | 23.5 | 28.8 |
| GLENN | 16.1 | 7.9 | 7.8 | 19.3 | 15.3 | 22.8 | 15.0 | 29.9 | 22.3 |
| HUMBOLDT | 16.8 | 21.6 | 23.8 | 46.2 | 38.7 | 37.8 | 28.8 | 30.3 | 25.4 |
| IMPERIAL | 0.0 | 2.6 | 0.8 | 2.4 | 18.9 | 14.8 | 13.6 | 13.5 | 16.1 |
| INYO | 32.8 | 49.2 | 43.7 | 16.3 | 32.5 | 21.7 | 32.7 | 10.9 | 27.3 |
| KERN | 9.5 | 18.9 | 22.8 | 14.5 | 16.7 | 21.4 | 26.4 | 23.8 | 27.2 |
| KINGS | 1.0 | 1.9 | 1.9 | 10.9 | 16.1 | 21.1 | 11.3 | 21.4 | 14.9 |
| LAKE | 5.9 | 0.0 | 9.4 | 7.4 | 7.3 | 7.3 | 20.0 | 7.3 | 5.4 |
| LASSEN | 7.2 | 21.5 | 3.6 | 3.5 | 14.0 | 10.5 | 13.1 | 5.8 | 5.9 |
| **LONG BEACH** | 18.4 | 19.1 | 20.1 | 16.6 | 13.9 | 12.8 | 21.2 | 20.9 | 15.0 |
| LOS ANGELES | 14.4 | 14.9 | 16.8 | 16.4 | 15.5 | 14.3 | 19.9 | 18.1 | 13.7 |
| MADERA | 14.8 | 3.3 | 29.1 | 25.9 | 30.8 | 16.1 | 33.2 | 28.6 | 30.7 |
| MARIN | 28.7 | 102.2 | 91.4 | 57.2 | 58.2 | 78.1 | 69.8 | 53.0 | 29.1 |
| MARIPOSA | 7.0 | 20.3 | 19.8 | 6.4 | 25.3 | 12.6 | 18.9 | 6.3 | 6.3 |
| MENDOCINO | 21.2 | 13.5 | 17.0 | 24.1 | 14.4 | 38.1 | 30.8 | 35.1 | 24.4 |
| MERCED | 15.7 | 39.8 | 36.2 | 33.4 | 47.5 | 38.4 | 47.9 | 40.5 | 19.7 |
| MODOC | 0.0 | 10.2 | 20.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30.1 |
| MONO | 20.1 | 19.9 | 10.0 | 29.3 | 104.3 | 0.0 | 28.4 | 9.5 | 0.0 |
| MONTEREY | 26.1 | 29.6 | 21.5 | 25.6 | 27.3 | 23.0 | 26.0 | 23.0 | 17.6 |
| NAPA | 50.6 | 53.5 | 69.5 | 59.0 | 60.1 | 53.8 | 55.7 | 60.8 | 36.1 |
| NEVADA | 7.6 | 26.1 | 15.8 | 20.3 | 11.8 | 12.8 | 24.2 | 16.0 | 7.8 |
| ORANGE | 14.0 | 12.4 | 12.4 | 13.4 | 7.5 | 17.1 | 17.0 | 15.1 | 10.4 |
| **PASADENA** | 16.7 | 21.1 | 24.0 | 16.3 | 27.3 | 17.6 | 12.4 | 16.6 | 18.5 |
| PLACER | 16.8 | 17.9 | 23.4 | 26.9 | 18.0 | 10.5 | 18.9 | 28.2 | 16.9 |
| PLUMAS | 15.2 | 35.3 | 24.7 | 19.5 | 19.4 | 29.3 | 9.8 | 19.7 | 0.0 |
| RIVERSIDE | 11.4 | 10.5 | 14.7 | 13.3 | 11.3 | 9.5 | 15.2 | 15.5 | 9.4 |
| SACRAMENTO | 24.6 | 35.2 | 22.1 | 13.4 | 22.9 | 9.5 | 7.6 | 12.0 | 13.5 |
| SAN BENITO | 10.9 | 24.1 | 26.2 | 38.1 | 51.9 | 43.1 | 41.5 | 15.5 | 19.2 |
| SAN BERNARDINO | 5.6 | 7.3 | 7.8 | 9.6 | 11.6 | 12.3 | 15.3 | 14.1 | 9.9 |
| SAN DIEGO | 17.8 | 18.5 | 21.2 | 21.7 | 33.4 | 26.9 | 26.0 | 19.8 | 16.6 |
| SAN FRANCISCO | 106.9 | 97.7 | 96.7 | 83.9 | 81.6 | 74.5 | 79.4 | 75.6 | 54.5 |
| SAN JOAQUIN | 51.2 | 52.0 | 45.0 | 45.0 | 41.5 | 38.9 | 44.1 | 39.4 | 28.5 |
| SAN LUIS OBISPO | 14.3 | 16.4 | 18.1 | 23.8 | 23.1 | 23.3 | 26.6 | 26.2 | 14.4 |
| SAN MATEO | 46.8 | 59.3 | 55.7 | 57.0 | 67.9 | 55.7 | 49.0 | 48.8 | 40.6 |
| SANTA BARBARA | 15.4 | 17.9 | 26.4 | 21.7 | 21.8 | 17.0 | 14.8 | 17.9 | 17.4 |
| SANTA CLARA | 26.2 | 28.7 | 30.8 | 36.0 | 36.5 | 31.4 | 26.6 | 25.4 | 19.4 |
| SANTA CRUZ | 22.6 | 22.9 | 12.0 | 46.2 | 42.1 | 37.9 | 41.2 | 44.0 | 29.3 |
| SHASTA | 16.3 | 7.3 | 7.7 | 11.4 | 24.5 | 13.7 | 5.6 | 11.1 | 12.2 |
| SIERRA | 0.0 | 0.0 | 60.6 | 60.2 | 89.6 | 29.7 | 29.6 | 59.5 | 29.9 |
| SISKIYOU | 16.1 | 18.3 | 18.3 | 31.7 | 33.7 | 24.6 | 29.3 | 4.5 | 15.8 |
| SOLANO | 20.3 | 24.5 | 25.9 | 29.9 | 34.7 | 26.5 | 29.6 | 27.7 | 19.4 |
| SONOMA | 25.2 | 25.9 | 37.9 | 55.7 | 41.4 | 35.3 | 40.3 | 38.5 | 31.4 |
| STANISLAUS | 23.8 | 24.3 | 23.5 | 29.7 | 40.8 | 33.3 | 34.4 | 33.9 | 36.9 |
| SUTTER | 18.6 | 18.1 | 11.7 | 20.0 | 26.5 | 24.7 | 25.6 | 17.2 | 17.0 |
| TEHAMA | 2.0 | 4.0 | 7.7 | 11.4 | 11.3 | 3.7 | 3.7 | 11.0 | 10.9 |
| TRINITY | 0.0 | 15.3 | 0.0 | 37.9 | 15.0 | 7.5 | 22.4 | 0.0 | 15.2 |
| TULARE | 21.2 | 16.0 | 18.0 | 18.2 | 29.6 | 27.7 | 32.7 | 27.8 | 26.7 |
| TUOLUMNE | 4.1 | 6.1 | 4.0 | 15.7 | 9.7 | 7.7 | 13.6 | 7.7 | 13.3 |
| VENTURA | 10.9 | 12.6 | 12.6 | 18.9 | 18.1 | 16.8 | 18.6 | 16.2 | 10.6 |
| YOLO | 36.8 | 27.2 | 29.6 | 30.0 | 27.1 | 32.1 | 42.2 | 26.7 | 40.5 |
| YUBA | 12.0 | 15.1 | 14.9 | 22.8 | 14.6 | 25.8 | 16.3 | 16.4 | 11.5 |

Table E-3a Reported Incidence of Salmonellosis in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 254 | 189 | 250 | 234 | 200 | 225 | 280 | 250 | 208 |
| ALPINE | | | 1 | | | | | | |
| AMADOR | 5 | 4 | 1 | 3 | 3 | 4 | 3 | 3 | 7 |
| BERKELEY | 20 | 15 | 28 | 17 | 15 | 20 | 33 | 23 | 15 |
| BUTTE | 36 | 24 | 36 | 29 | 32 | 35 | 28 | 23 | 16 |
| CALAVERAS | 3 | 1 | 2 | 2 | 3 | 1 | 5 | 6 | 5 |
| COLUSA | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 |
| CONTRA COSTA | 182 | 124 | 96 | 162 | 124 | 135 | 111 | 148 | 109 |
| DEL NORTE | | 5 | 7 | 6 | 3 | | 2 | 3 | 1 |
| EL DORADO | 17 | 9 | 12 | 14 | 13 | 16 | 30 | 17 | 20 |
| FRESNO | 66 | 132 | 94 | 81 | 135 | 91 | 103 | 119 | 97 |
| GLENN | 7 | 2 | 4 | 2 | 1 | 6 | 6 | 6 | 1 |
| HUMBOLDT | 10 | 25 | 19 | 27 | 16 | 13 | 14 | 9 | 12 |
| IMPERIAL | 46 | 38 | 36 | 60 | 48 | 24 | 40 | 34 | 31 |
| INYO | 5 | 7 | 9 | 3 | 15 | 9 | 6 | 6 | |
| KERN | 76 | 68 | 79 | 88 | 96 | 93 | 136 | 69 | 102 |
| KINGS | 9 | 13 | 6 | 25 | 10 | 14 | 17 | 14 | 5 |
| LAKE | 6 | 4 | 6 | 4 | 2 | 14 | 11 | 7 | 6 |
| LASSEN | 4 | 11 | 6 | 3 | 2 | | 4 | 4 | 2 |
| LONG BEACH | 100 | 71 | 88 | 89 | 107 | 107 | 104 | 102 | 82 |
| LOS ANGELES | 1607 | 1555 | 1681 | 1583 | 2140 | 2007 | 1774 | 1699 | 1406 |
| MADERA | 9 | 13 | 22 | 29 | 28 | 24 | 22 | 19 | 14 |
| MARIN | 43 | 30 | 59 | 31 | 33 | 36 | 35 | 50 | 44 |
| MARIPOSA | | 3 | 1 | 1 | 5 | 5 | 3 | 1 | |
| MENDOCINO | 5 | 9 | 13 | 15 | 14 | 5 | 10 | 9 | 9 |
| MERCED | 28 | 19 | 33 | 44 | 31 | 69 | 44 | 44 | 41 |
| MODOC | 1 | 1 | | 1 | 3 | 1 | 1 | 1 | |
| MONO | | | | 5 | 8 | 4 | 16 | 4 | |
| MONTEREY | 45 | 40 | 45 | 47 | 39 | 48 | 72 | 46 | 39 |
| NAPA | 20 | 12 | 15 | 23 | 21 | 31 | 24 | 17 | 10 |
| NEVADA | 13 | 15 | 12 | 14 | 10 | 8 | 22 | 11 | 11 |
| ORANGE | 369 | 316 | 388 | 412 | 277 | 625 | 555 | 551 | 334 |
| PASADENA | 41 | 34 | 42 | 36 | 49 | 33 | 35 | 36 | 22 |
| PLACER | 25 | 19 | 36 | 32 | 28 | 16 | 49 | 31 | 54 |
| PLUMAS | 1 | 2 | 8 | 6 | 5 | 4 | 7 | 2 | 2 |
| RIVERSIDE | 183 | 185 | 215 | 213 | 289 | 265 | 229 | 205 | 166 |
| SACRAMENTO | 247 | 205 | 213 | 193 | 121 | 114 | 180 | 126 | 135 |
| SAN BENITO | 10 | 7 | 4 | 3 | 11 | 6 | 7 | 8 | 8 |
| SAN BERNARDINO | 186 | 184 | 228 | 266 | 418 | 361 | 279 | 247 | 145 |
| SAN DIEGO | 450 | 584 | 540 | 492 | 539 | 570 | 620 | 574 | 424 |
| SAN FRANCISCO | 215 | 181 | 218 | 200 | 199 | 193 | 184 | 216 | 186 |
| SAN JOAQUIN | 144 | 90 | 99 | 112 | 105 | 66 | 90 | 70 | 84 |
| SAN LUIS OBISPO | 36 | 23 | 22 | 27 | 28 | 45 | 43 | 35 | 33 |
| SAN MATEO | 187 | 151 | 169 | 150 | 132 | 140 | 167 | 208 | 102 |
| SANTA BARBARA | 65 | 69 | 79 | 48 | 47 | 80 | 87 | 62 | 59 |
| SANTA CLARA | 372 | 288 | 307 | 391 | 273 | 352 | 484 | 372 | 282 |
| SANTA CRUZ | 38 | 34 | 58 | 45 | 50 | 44 | 60 | 57 | 37 |
| SHASTA | 17 | 18 | 21 | 25 | 12 | 8 | 6 | 14 | 6 |
| SIERRA | | | | 3 | | | | 1 | |
| SISKIYOU | 6 | 5 | 5 | 5 | 12 | 2 | | 6 | 4 |
| SOLANO | 69 | 32 | 49 | 71 | 31 | 52 | 63 | 43 | 47 |
| SONOMA | 57 | 54 | 59 | 77 | 52 | 52 | 64 | 71 | 56 |
| STANISLAUS | 100 | 61 | 63 | 52 | 62 | 68 | 95 | 129 | 58 |
| SUTTER | 7 | 16 | 13 | 7 | 10 | 8 | 15 | 7 | 8 |
| TEHAMA | 4 | 7 | 2 | 6 | 7 | 2 | 5 | 7 | 3 |
| TRINITY | 1 | 1 | 2 | | 5 | 2 | | 1 | |
| TULARE | 55 | 67 | 70 | 66 | 183 | 83 | 68 | 66 | 64 |
| TUOLUMNE | 8 | 4 | 4 | 11 | 3 | 3 | 11 | 6 | 5 |
| VENTURA | 84 | 75 | 98 | 75 | 93 | 106 | 156 | 81 | 109 |
| YOLO | 15 | 25 | 21 | 25 | 17 | 6 | 14 | 11 | 8 |
| YUBA | 6 | 4 | 10 | 5 | 10 | 3 | 12 | 5 | 4 |
| Grand Total | 5616 | 5181 | 5705 | 5697 | 6226 | 6356 | 6544 | 5993 | 4739 |

Table E-3b Reported Incidence of Salmonellosis in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 21.6 | 15.9 | 20.7 | 19.1 | 16.2 | 18.1 | 22.4 | 19.6 | 15.9 |
| ALPINE | 0.0 | 0.0 | 88.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AMADOR | 16.6 | 13.0 | 3.2 | 9.4 | 9.3 | 12.3 | 9.2 | 9.0 | 21.0 |
| **BERKELEY** | 19.5 | 14.5 | 26.9 | 16.3 | 14.4 | 19.1 | 31.5 | 21.6 | 13.9 |
| BUTTE | 19.8 | 13.0 | 19.2 | 15.2 | 16.6 | 18.0 | 14.3 | 11.6 | 8.0 |
| CALAVERAS | 9.4 | 3.0 | 5.8 | 5.7 | 8.3 | 2.7 | 13.5 | 16.2 | 13.1 |
| COLUSA | 6.1 | 6.0 | 5.9 | 5.8 | 5.7 | 11.3 | 16.6 | 5.4 | 5.4 |
| CONTRA COSTA | 22.6 | 15.2 | 11.6 | 19.2 | 14.5 | 15.6 | 12.7 | 16.7 | 12.0 |
| DEL NORTE | 0.0 | 19.8 | 26.4 | 22.2 | 10.9 | 0.0 | 7.3 | 10.7 | 3.6 |
| EL DORADO | 13.5 | 6.9 | 8.9 | 10.2 | 9.2 | 11.2 | 20.8 | 11.8 | 13.4 |
| FRESNO | 9.9 | 19.2 | 13.3 | 11.2 | 18.4 | 12.2 | 13.5 | 15.4 | 12.4 |
| GLENN | 28.2 | 7.9 | 15.6 | 7.7 | 3.8 | 22.8 | 22.5 | 22.4 | 3.7 |
| HUMBOLDT | 8.4 | 20.7 | 15.6 | 21.9 | 12.9 | 10.5 | 11.2 | 7.2 | 9.5 |
| IMPERIAL | 42.1 | 33.5 | 30.2 | 47.5 | 36.3 | 17.7 | 28.7 | 24.1 | 21.7 |
| INYO | 27.4 | 38.3 | 49.2 | 16.3 | 81.3 | 48.8 | 32.7 | 32.8 | 0.0 |
| KERN | 13.9 | 12.1 | 13.6 | 14.8 | 15.9 | 15.2 | 21.9 | 11.0 | 16.0 |
| KINGS | 8.9 | 12.5 | 5.6 | 22.8 | 8.9 | 12.3 | 14.7 | 12.0 | 4.1 |
| LAKE | 11.9 | 7.7 | 11.3 | 7.4 | 3.7 | 25.5 | 20.0 | 12.7 | 10.9 |
| LASSEN | 14.5 | 39.5 | 21.3 | 10.5 | 7.0 | 0.0 | 13.1 | 11.6 | 5.9 |
| **LONG BEACH** | 23.3 | 16.2 | 19.9 | 20.2 | 24.4 | 24.5 | 23.7 | 23.1 | 18.4 |
| LOS ANGELES | 19.4 | 18.5 | 19.8 | 18.3 | 24.6 | 22.9 | 20.2 | 19.1 | 15.6 |
| MADERA | 10.2 | 14.1 | 22.9 | 28.9 | 27.0 | 22.7 | 20.3 | 17.0 | 12.3 |
| MARIN | 18.7 | 12.9 | 25.2 | 13.1 | 13.9 | 15.1 | 14.6 | 20.7 | 18.0 |
| MARIPOSA | 0.0 | 20.3 | 6.6 | 6.4 | 31.6 | 31.5 | 18.9 | 6.3 | 0.0 |
| MENDOCINO | 6.2 | 11.0 | 15.8 | 18.1 | 16.7 | 6.0 | 11.8 | 10.5 | 10.5 |
| MERCED | 15.7 | 10.4 | 17.5 | 22.9 | 15.8 | 34.9 | 22.2 | 22.0 | 20.2 |
| MODOC | 10.3 | 10.2 | 0.0 | 10.0 | 29.9 | 10.0 | 10.0 | 9.9 | 0.0 |
| MONO | 0.0 | 0.0 | 0.0 | 48.8 | 75.8 | 37.7 | 151.7 | 38.1 | 0.0 |
| MONTEREY | 12.7 | 11.1 | 12.3 | 12.7 | 10.6 | 13.3 | 19.9 | 12.5 | 10.2 |
| NAPA | 18.1 | 10.7 | 13.2 | 19.9 | 18.0 | 26.5 | 20.3 | 14.2 | 8.2 |
| NEVADA | 16.6 | 18.7 | 14.6 | 16.7 | 11.8 | 9.3 | 25.3 | 12.5 | 12.3 |
| ORANGE | 15.3 | 12.9 | 15.6 | 16.3 | 10.8 | 24.1 | 21.1 | 20.6 | 12.2 |
| **PASADENA** | 31.2 | 25.7 | 31.4 | 26.7 | 36.2 | 24.2 | 25.5 | 26.0 | 15.7 |
| PLACER | 14.5 | 10.7 | 19.6 | 16.9 | 14.4 | 8.0 | 23.8 | 14.6 | 24.6 |
| PLUMAS | 5.1 | 10.1 | 39.5 | 29.2 | 24.3 | 19.5 | 34.3 | 9.8 | 9.8 |
| RIVERSIDE | 15.6 | 15.1 | 16.9 | 16.3 | 21.7 | 19.5 | 16.6 | 14.6 | 11.5 |
| SACRAMENTO | 23.7 | 19.3 | 19.6 | 17.5 | 10.9 | 10.2 | 16.0 | 11.1 | 11.7 |
| SAN BENITO | 27.3 | 18.7 | 10.5 | 7.6 | 27.2 | 14.4 | 16.1 | 17.8 | 17.0 |
| SAN BERNARDINO | 13.1 | 12.6 | 15.1 | 17.3 | 26.8 | 23.0 | 17.6 | 15.4 | 8.9 |
| SAN DIEGO | 18.0 | 23.0 | 20.9 | 18.8 | 20.4 | 21.4 | 23.1 | 21.0 | 15.2 |
| SAN FRANCISCO | 29.7 | 24.8 | 29.6 | 26.9 | 26.5 | 25.7 | 24.2 | 28.0 | 23.7 |
| SAN JOAQUIN | 30.0 | 18.4 | 19.8 | 22.1 | 20.5 | 12.7 | 17.0 | 13.0 | 15.4 |
| SAN LUIS OBISPO | 16.6 | 10.5 | 10.0 | 12.1 | 12.4 | 19.8 | 18.7 | 15.0 | 14.0 |
| SAN MATEO | 28.8 | 23.0 | 25.4 | 22.3 | 19.4 | 20.4 | 24.1 | 29.5 | 14.2 |
| SANTA BARBARA | 17.6 | 18.4 | 20.8 | 12.6 | 12.2 | 20.6 | 22.2 | 15.6 | 14.6 |
| SANTA CLARA | 24.8 | 19.0 | 20.0 | 25.1 | 17.3 | 22.1 | 29.9 | 22.5 | 16.7 |
| SANTA CRUZ | 16.5 | 14.7 | 24.8 | 19.1 | 21.0 | 18.3 | 24.7 | 23.2 | 14.9 |
| SHASTA | 11.6 | 11.9 | 13.5 | 15.9 | 7.5 | 5.0 | 3.7 | 8.6 | 3.7 |
| SIERRA | 0.0 | 0.0 | 0.0 | 90.4 | 0.0 | 0.0 | 0.0 | 29.8 | 0.0 |
| SISKIYOU | 13.8 | 11.4 | 11.4 | 11.3 | 26.9 | 4.5 | 0.0 | 13.6 | 9.0 |
| SOLANO | 20.3 | 9.1 | 13.7 | 19.5 | 8.4 | 14.0 | 17.0 | 11.5 | 12.3 |
| SONOMA | 14.7 | 13.7 | 14.7 | 18.9 | 12.6 | 12.5 | 15.2 | 16.6 | 12.8 |
| STANISLAUS | 27.0 | 16.0 | 16.1 | 13.0 | 15.2 | 16.5 | 22.8 | 30.6 | 13.5 |
| SUTTER | 10.9 | 24.2 | 19.1 | 10.0 | 13.9 | 11.0 | 20.2 | 9.3 | 10.5 |
| TEHAMA | 8.1 | 13.8 | 3.9 | 11.4 | 13.2 | 3.7 | 9.2 | 12.8 | 5.5 |
| TRINITY | 7.7 | 7.7 | 15.3 | 0.0 | 37.5 | 14.9 | 0.0 | 7.5 | 0.0 |
| TULARE | 17.6 | 21.0 | 21.3 | 19.7 | 53.7 | 24.0 | 19.3 | 18.5 | 17.8 |
| TUOLUMNE | 16.5 | 8.1 | 8.0 | 21.5 | 5.8 | 5.8 | 21.3 | 11.6 | 9.5 |
| VENTURA | 12.6 | 11.1 | 14.3 | 10.8 | 13.2 | 14.9 | 21.9 | 11.2 | 14.9 |
| YOLO | 10.6 | 17.5 | 14.4 | 17.0 | 11.5 | 4.0 | 9.2 | 7.2 | 5.1 |
| YUBA | 10.3 | 6.7 | 16.5 | 8.1 | 16.2 | 4.8 | 19.5 | 8.2 | 6.6 |

Table E-4a Reported Incidence of Shigellosis Type A in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 8 | 2 | 4 | 5 | 1 | 3 | 3 | 10 | 2 |
| BUTTE | | | | | 2 | 1 | | | |
| COLUSA | | 1 | | | | | | | |
| CONTRA COSTA | 3 | | 1 | | 1 | | | 1 | |
| EL DORADO | | | | | | 2 | | | |
| FRESNO | | 3 | 1 | 6 | 6 | 1 | | | |
| IMPERIAL | | 1 | | | | 1 | | | |
| KERN | 2 | | 1 | 2 | | | | | |
| KINGS | | 2 | | | 1 | 2 | | | |
| LASSEN | | | | | | | 1 | | 1 |
| LONG BEACH | 5 | | 1 | 1 | | 1 | 1 | | |
| LOS ANGELES | 32 | 22 | 21 | 14 | 10 | 9 | 16 | 2 | 5 |
| MADERA | | | 1 | 1 | | 1 | | | |
| MARIN | 1 | | | | | | 1 | | 4 |
| MERCED | 1 | | 1 | | | | 2 | | |
| MODOC | | | | | | | | 1 | |
| MONTEREY | 1 | | | 1 | 1 | | | 2 | |
| NAPA | 1 | 1 | | | | | | | |
| ORANGE | 9 | 13 | 7 | 8 | 3 | 3 | 3 | 4 | 2 |
| PASADENA | 1 | 1 | | | 1 | 1 | | | |
| PLACER | 1 | | | | | | | | 1 |
| RIVERSIDE | 3 | 2 | 6 | 1 | 1 | 1 | 1 | 1 | 1 |
| SACRAMENTO | 1 | | | 1 | 1 | | 1 | 1 | |
| SAN BENITO | | | | | 3 | 2 | | | |
| SAN BERNARDINO | 3 | 4 | 1 | 1 | 3 | 3 | 1 | | 1 |
| SAN DIEGO | 11 | 11 | 6 | 10 | 6 | 9 | 3 | 1 | 1 |
| SAN FRANCISCO | 3 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | |
| SAN JOAQUIN | 2 | 2 | 1 | 1 | 1 | | | | 1 |
| SAN LUIS OBISPO | | | 1 | | 1 | | | | |
| SAN MATEO | 1 | 3 | 2 | 1 | 3 | 1 | | | |
| SANTA BARBARA | | | | 2 | | 1 | 1 | | |
| SANTA CLARA | 4 | 3 | 6 | 3 | 3 | 4 | | 2 | 2 |
| SANTA CRUZ | 3 | | 1 | | 1 | | 1 | | |
| SHASTA | | | | | | | 1 | | |
| SOLANO | 4 | 1 | 1 | | | | | | 1 |
| SONOMA | 3 | | | | | | 1 | | 1 |
| STANISLAUS | 1 | | 3 | 1 | | | | | |
| SUTTER | | 1 | | | | | 1 | | |
| TEHAMA | | | 1 | | | | | | |
| TULARE | 3 | 1 | 1 | | | 1 | | | 1 |
| VENTURA | 3 | 2 | 1 | | 2 | 1 | | | |
| Grand Total | 110 | 77 | 72 | 61 | 54 | 50 | 41 | 27 | 24 |

Table E-4b Reported Incidence of Shigellosis Type A in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 0.7 | 0.2 | 0.3 | 0.4 | 0.1 | 0.2 | 0.2 | 0.8 | 0.2 |
| BUTTE | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| COLUSA | 0.0 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CONTRA COSTA | 0.4 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| EL DORADO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 |
| FRESNO | 0.0 | 0.4 | 0.1 | 0.8 | 0.8 | 0.1 | 0.0 | 0.0 | 0.0 |
| IMPERIAL | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 |
| KERN | 0.4 | 0.0 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| KINGS | 0.0 | 1.9 | 0.0 | 0.0 | 0.9 | 1.8 | 0.0 | 0.0 | 0.0 |
| LASSEN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 0.0 | 3.0 |
| **LONG BEACH** | 1.2 | 0.0 | 0.2 | 0.2 | 0.0 | 0.2 | 0.2 | 0.0 | 0.0 |
| LOS ANGELES | 0.4 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.1 |
| MADERA | 0.0 | 0.0 | 1.0 | 1.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| MARIN | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 1.6 |
| MERCED | 0.6 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| MODOC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 0.0 |
| MONTEREY | 0.3 | 0.0 | 0.0 | 0.3 | 0.3 | 0.0 | 0.0 | 0.5 | 0.0 |
| NAPA | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ORANGE | 0.4 | 0.5 | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| **PASADENA** | 0.8 | 0.8 | 0.0 | 0.0 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 |
| PLACER | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| RIVERSIDE | 0.3 | 0.2 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SACRAMENTO | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 |
| SAN BENITO | 0.0 | 0.0 | 0.0 | 0.0 | 7.4 | 4.8 | 0.0 | 0.0 | 0.0 |
| SAN BERNARDINO | 0.2 | 0.3 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.0 | 0.1 |
| SAN DIEGO | 0.4 | 0.4 | 0.2 | 0.4 | 0.2 | 0.3 | 0.1 | 0.0 | 0.0 |
| SAN FRANCISCO | 0.4 | 0.1 | 0.4 | 0.3 | 0.4 | 0.3 | 0.4 | 0.3 | 0.0 |
| SAN JOAQUIN | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 |
| SAN LUIS OBISPO | 0.0 | 0.0 | 0.5 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| SAN MATEO | 0.2 | 0.5 | 0.3 | 0.1 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 |
| SANTA BARBARA | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.3 | 0.3 | 0.0 | 0.0 |
| SANTA CLARA | 0.3 | 0.2 | 0.4 | 0.2 | 0.2 | 0.3 | 0.0 | 0.1 | 0.1 |
| SANTA CRUZ | 1.3 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.0 |
| SHASTA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 |
| SOLANO | 1.2 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| SONOMA | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 |
| STANISLAUS | 0.3 | 0.0 | 0.8 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SUTTER | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 |
| TEHAMA | 0.0 | 0.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TULARE | 1.0 | 0.3 | 0.3 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.3 |
| VENTURA | 0.4 | 0.3 | 0.1 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |

Table E-5a Reported Incidence of Shigellosis Type B in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 44 | 42 | 33 | 27 | 26 | 23 | 27 | 59 | 28 |
| ALPINE | | | | | 1 | | | | |
| AMADOR | | | | 1 | | | | | |
| BERKELEY | 6 | 6 | 1 | 4 | 4 | 3 | 2 | 1 | 1 |
| BUTTE | 1 | 2 | 1 | | | 1 | 2 | | |
| COLUSA | | | | | 1 | | 1 | 3 | 1 |
| CONTRA COSTA | 18 | 3 | 7 | 15 | 15 | 9 | 14 | 15 | 8 |
| EL DORADO | | | | | | 1 | | | |
| FRESNO | 40 | 22 | 29 | 27 | 42 | 36 | 25 | 22 | 16 |
| GLENN | 3 | 4 | 3 | | | | | | |
| HUMBOLDT | | | 1 | 1 | 1 | | | 2 | |
| IMPERIAL | 10 | | 4 | 5 | 8 | 4 | 7 | 1 | 1 |
| INYO | 3 | | | 1 | | | 1 | | |
| KERN | 12 | 16 | 10 | 6 | 6 | 4 | 5 | 2 | |
| KINGS | 1 | | 5 | 4 | 5 | 1 | | 1 | |
| LAKE | | | | | 1 | | | | |
| LONG BEACH | 32 | 24 | 39 | 36 | 46 | 28 | 29 | 26 | 19 |
| LOS ANGELES | 686 | 685 | 704 | 526 | 516 | 470 | 390 | 313 | 234 |
| MADERA | 2 | 11 | 12 | 10 | 4 | 11 | 12 | | 1 |
| MARIN | 14 | 7 | 4 | 6 | 2 | 3 | 5 | 8 | 6 |
| MARIPOSA | | | | | | 1 | | | |
| MENDOCINO | | | 2 | 1 | | | 1 | 4 | 2 |
| MERCED | 2 | | 4 | 2 | 1 | 1 | 2 | 1 | 2 |
| MODOC | 1 | | | | 1 | | | | |
| MONO | | | | | 1 | 1 | 1 | | 1 |
| MONTEREY | 26 | 42 | 25 | 11 | 14 | 13 | 11 | 9 | 6 |
| NAPA | 4 | 8 | | 4 | 4 | 2 | 5 | 4 | 9 |
| NEVADA | 1 | | | | | | | 1 | |
| ORANGE | 153 | 132 | 133 | 135 | 90 | 127 | 124 | 70 | 61 |
| PASADENA | 7 | 7 | 12 | 4 | 9 | 5 | 6 | 6 | 4 |
| PLACER | 3 | 1 | 2 | 3 | 3 | 1 | 1 | | 2 |
| PLUMAS | | 1 | 3 | | | | | | |
| RIVERSIDE | 44 | 43 | 53 | 54 | 41 | 43 | 29 | 16 | 40 |
| SACRAMENTO | 26 | 19 | 20 | 11 | 8 | 4 | 11 | 11 | 14 |
| SAN BENITO | 2 | | 2 | 2 | 5 | 4 | 10 | 2 | 3 |
| SAN BERNARDINO | 67 | 73 | 46 | 44 | 68 | 38 | 48 | 22 | 19 |
| SAN DIEGO | 202 | 153 | 138 | 155 | 139 | 154 | 161 | 139 | 67 |
| SAN FRANCISCO | 221 | 140 | 149 | 129 | 127 | 96 | 88 | 111 | 73 |
| SAN JOAQUIN | 46 | 43 | 30 | 15 | 20 | 31 | 31 | 16 | 18 |
| SAN LUIS OBISPO | 2 | 4 | 4 | 4 | 4 | 1 | 2 | 5 | 2 |
| SAN MATEO | 51 | 41 | 32 | 22 | 27 | 21 | 16 | 20 | 34 |
| SANTA BARBARA | 24 | 19 | 18 | 18 | 10 | 17 | 17 | 16 | 14 |
| SANTA CLARA | 65 | 66 | 68 | 66 | 61 | 50 | 39 | 42 | 35 |
| SANTA CRUZ | 17 | 3 | 17 | 9 | 18 | 5 | 3 | 10 | 3 |
| SHASTA | 5 | 2 | 1 | 1 | 1 | | | | |
| SOLANO | 19 | 10 | 6 | 6 | 2 | 4 | 3 | 11 | 3 |
| SONOMA | 12 | 11 | 9 | 4 | 10 | 5 | 6 | 7 | 11 |
| STANISLAUS | 17 | 12 | 13 | 18 | 6 | 11 | 15 | 7 | 14 |
| SUTTER | 5 | 3 | 4 | 3 | 3 | 2 | 2 | 2 | 1 |
| TEHAMA | | | 1 | 1 | | | | | |
| TULARE | 35 | 19 | 42 | 29 | 32 | 23 | 4 | 3 | 7 |
| VENTURA | 25 | 19 | 12 | 13 | 10 | 17 | 10 | 12 | 8 |
| YOLO | 3 | 1 | 2 | | 1 | | | | 2 |
| YUBA | | 3 | 1 | 2 | 3 | | | | |
| Grand Total | 1957 | 1697 | 1702 | 1435 | 1397 | 1271 | 1166 | 1000 | 770 |

Table E-5b Reported Incidence of Shigellosis Type B in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 3.7 | 3.5 | 2.7 | 2.2 | 2.1 | 1.9 | 2.2 | 4.6 | 2.1 |
| ALPINE | 0.0 | 0.0 | 0.0 | 0.0 | 88.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| AMADOR | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **BERKELEY** | 5.8 | 5.8 | 1.0 | 3.8 | 3.8 | 2.9 | 1.9 | 0.9 | 0.9 |
| BUTTE | 0.5 | 1.1 | 0.5 | 0.0 | 0.0 | 0.5 | 1.0 | 0.0 | 0.0 |
| COLUSA | 0.0 | 0.0 | 0.0 | 0.0 | 5.7 | 0.0 | 5.5 | 16.3 | 5.4 |
| CONTRA COSTA | 2.2 | 0.4 | 0.8 | 1.8 | 1.8 | 1.0 | 1.6 | 1.7 | 0.9 |
| EL DORADO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 |
| FRESNO | 6.0 | 3.2 | 4.1 | 3.7 | 5.7 | 4.8 | 3.3 | 2.8 | 2.0 |
| GLENN | 12.1 | 15.9 | 11.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HUMBOLDT | 0.0 | 0.0 | 0.8 | 0.8 | 0.8 | 0.0 | 0.0 | 1.6 | 0.0 |
| IMPERIAL | 9.1 | 0.0 | 3.4 | 4.0 | 6.1 | 3.0 | 5.0 | 0.7 | 0.7 |
| INYO | 16.4 | 0.0 | 0.0 | 5.4 | 0.0 | 0.0 | 5.4 | 0.0 | 0.0 |
| KERN | 2.2 | 2.9 | 1.7 | 1.0 | 1.0 | 0.7 | 0.8 | 0.3 | 0.0 |
| KINGS | 1.0 | 0.0 | 4.7 | 3.6 | 4.5 | 0.9 | 0.0 | 0.9 | 0.0 |
| LAKE | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| **LONG BEACH** | 7.5 | 5.5 | 8.8 | 8.2 | 10.5 | 6.4 | 6.6 | 5.9 | 4.3 |
| LOS ANGELES | 8.3 | 8.1 | 8.3 | 6.1 | 5.9 | 5.4 | 4.4 | 3.5 | 2.6 |
| MADERA | 2.3 | 12.0 | 12.5 | 10.0 | 3.9 | 10.4 | 11.1 | 0.0 | 0.9 |
| MARIN | 6.1 | 3.0 | 1.7 | 2.5 | 0.8 | 1.3 | 2.1 | 3.3 | 2.5 |
| MARIPOSA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.3 | 0.0 | 0.0 | 0.0 |
| MENDOCINO | 0.0 | 0.0 | 2.4 | 1.2 | 0.0 | 0.0 | 1.2 | 4.7 | 2.3 |
| MERCED | 1.1 | 0.0 | 2.1 | 1.0 | 0.5 | 0.5 | 1.0 | 0.5 | 1.0 |
| MODOC | 10.3 | 0.0 | 0.0 | 0.0 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MONO | 0.0 | 0.0 | 0.0 | 0.0 | 9.5 | 9.4 | 9.5 | 0.0 | 9.5 |
| MONTEREY | 7.3 | 11.6 | 6.8 | 3.0 | 3.8 | 3.6 | 3.0 | 2.4 | 1.6 |
| NAPA | 3.6 | 7.1 | 0.0 | 3.5 | 3.4 | 1.7 | 4.2 | 3.3 | 7.4 |
| NEVADA | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 |
| ORANGE | 6.3 | 5.4 | 5.3 | 5.3 | 3.5 | 4.9 | 4.7 | 2.6 | 2.2 |
| **PASADENA** | 5.3 | 5.3 | 9.0 | 3.0 | 6.6 | 3.7 | 4.4 | 4.3 | 2.9 |
| PLACER | 1.7 | 0.6 | 1.1 | 1.6 | 1.5 | 0.5 | 0.5 | 0.0 | 0.9 |
| PLUMAS | 0.0 | 5.0 | 14.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| RIVERSIDE | 3.8 | 3.5 | 4.2 | 4.1 | 3.1 | 3.2 | 2.1 | 1.1 | 2.8 |
| SACRAMENTO | 2.5 | 1.8 | 1.8 | 1.0 | 0.7 | 0.4 | 1.0 | 1.0 | 1.2 |
| SAN BENITO | 5.5 | 0.0 | 5.2 | 5.1 | 12.3 | 9.6 | 23.1 | 4.4 | 6.4 |
| SAN BERNARDINO | 4.7 | 5.0 | 3.0 | 2.9 | 4.4 | 2.4 | 3.0 | 1.4 | 1.2 |
| SAN DIEGO | 8.1 | 6.0 | 5.3 | 5.9 | 5.3 | 5.8 | 6.0 | 5.1 | 2.4 |
| SAN FRANCISCO | 30.5 | 19.1 | 20.3 | 17.3 | 16.9 | 12.8 | 11.6 | 14.4 | 9.3 |
| SAN JOAQUIN | 9.6 | 8.8 | 6.0 | 3.0 | 3.9 | 6.0 | 5.9 | 3.0 | 3.3 |
| SAN LUIS OBISPO | 0.9 | 1.8 | 1.8 | 1.8 | 1.8 | 0.4 | 0.9 | 2.1 | 0.8 |
| SAN MATEO | 7.9 | 6.2 | 4.8 | 3.3 | 4.0 | 3.1 | 2.3 | 2.8 | 4.7 |
| SANTA BARBARA | 6.5 | 5.1 | 4.7 | 4.7 | 2.6 | 4.4 | 4.3 | 4.0 | 3.5 |
| SANTA CLARA | 4.3 | 4.4 | 4.4 | 4.2 | 3.9 | 3.1 | 2.4 | 2.5 | 2.1 |
| SANTA CRUZ | 7.4 | 1.3 | 7.3 | 3.8 | 7.6 | 2.1 | 1.2 | 4.1 | 1.2 |
| SHASTA | 3.4 | 1.3 | 0.6 | 0.6 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| SOLANO | 5.6 | 2.9 | 1.7 | 1.6 | 0.5 | 1.1 | 0.8 | 2.9 | 0.8 |
| SONOMA | 3.1 | 2.8 | 2.2 | 1.0 | 2.4 | 1.2 | 1.4 | 1.6 | 2.5 |
| STANISLAUS | 4.6 | 3.1 | 3.3 | 4.5 | 1.5 | 2.7 | 3.6 | 1.7 | 3.3 |
| SUTTER | 7.8 | 4.5 | 5.9 | 4.3 | 4.2 | 2.7 | 2.7 | 2.7 | 1.3 |
| TEHAMA | 0.0 | 0.0 | 1.9 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TULARE | 11.2 | 5.9 | 12.8 | 8.7 | 9.4 | 6.6 | 1.1 | 0.8 | 1.9 |
| VENTURA | 3.7 | 2.8 | 1.8 | 1.9 | 1.4 | 2.4 | 1.4 | 1.7 | 1.1 |
| YOLO | 2.1 | 0.7 | 1.4 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 1.3 |
| YUBA | 0.0 | 5.0 | 1.7 | 3.3 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 |

Table E-6a Reported Incidence of Shigellosis Type C in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 6 | 3 | 1 | | 2 | 2 | 3 | 3 | 2 |
| BERKELEY | | | | 1 | 1 | | | | |
| COLUSA | | | | | | | 1 | | |
| CONTRA COSTA | 3 | | | 1 | 1 | 4 | 1 | 1 | |
| DEL NORTE | | | 1 | | | | | | |
| FRESNO | 3 | 3 | | 2 | 1 | | | 1 | 1 |
| IMPERIAL | 3 | | | 4 | | 1 | 1 | 1 | |
| KINGS | | | | | | 1 | | | |
| LASSEN | | | | | | | 1 | | |
| LONG BEACH | 3 | 5 | | 1 | 2 | | 3 | 2 | 2 |
| LOS ANGELES | 91 | 56 | 61 | 43 | 38 | 25 | 26 | 28 | 31 |
| MADERA | | 2 | | | | | | | |
| MARIN | | 2 | | | | 1 | | 2 | 1 |
| MENDOCINO | | | | | | | 5 | | |
| MERCED | | | | 1 | | | 1 | | |
| MONO | | | | | | 1 | | | |
| MONTEREY | 2 | 1 | 4 | | | 1 | | 3 | 1 |
| NAPA | | 1 | 1 | | 1 | | | | |
| ORANGE | 12 | 15 | 11 | 10 | 10 | 8 | 15 | 11 | 5 |
| PASADENA | 2 | | | | | | 2 | 1 | |
| PLACER | 1 | | 2 | | | | 1 | | |
| PLUMAS | | | | | | | | | 3 |
| RIVERSIDE | 1 | 4 | 3 | 1 | 2 | 6 | 3 | 6 | |
| SACRAMENTO | 1 | 2 | 3 | | | 1 | 2 | 2 | 1 |
| SAN BENITO | | | | 4 | | 1 | 4 | 2 | |
| SAN BERNARDINO | 7 | 3 | 3 | 5 | 3 | 3 | 2 | 8 | 3 |
| SAN DIEGO | 28 | 25 | 14 | 14 | 10 | 14 | 12 | 17 | 12 |
| SAN FRANCISCO | 8 | 6 | 2 | 3 | 5 | 4 | 5 | 1 | 5 |
| SAN JOAQUIN | 3 | 5 | 1 | 2 | | 2 | 3 | | 1 |
| SAN LUIS OBISPO | | | | 1 | | 1 | | | |
| SAN MATEO | 8 | 5 | 5 | 3 | 4 | 2 | 1 | 4 | |
| SANTA BARBARA | 3 | 3 | 1 | | | 1 | | | 2 |
| SANTA CLARA | 24 | 10 | 14 | 1 | 3 | 4 | 8 | 7 | 22 |
| SANTA CRUZ | | | 1 | 1 | | | | | 2 |
| SOLANO | 7 | | 2 | 1 | | 2 | | 1 | |
| SONOMA | | | | 1 | 1 | 1 | | | |
| STANISLAUS | 2 | 2 | 2 | | 1 | 2 | | | 1 |
| SUTTER | | | | | | 1 | | | 1 |
| TEHAMA | | | | 1 | | | | | |
| TULARE | 6 | 3 | 1 | 1 | 2 | 1 | | 1 | |
| VENTURA | 7 | | | 1 | | 1 | 2 | 1 | 3 |
| YOLO | 1 | | 1 | | | | | 2 | |
| YUBA | | | 1 | | | | | | |
| Grand Total | 232 | 156 | 135 | 103 | 87 | 91 | 102 | 105 | 99 |

Table E-6b Reported Incidence of Shigellosis Type C in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 0.5 | 0.3 | 0.1 | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| **BERKELEY** | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| COLUSA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | 0.0 | 0.0 |
| CONTRA COSTA | 0.4 | 0.0 | 0.0 | 0.1 | 0.1 | 0.5 | 0.1 | 0.1 | 0.0 |
| DEL NORTE | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FRESNO | 0.4 | 0.4 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| IMPERIAL | 2.7 | 0.0 | 0.0 | 3.2 | 0.0 | 0.7 | 0.7 | 0.7 | 0.0 |
| KINGS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| LASSEN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 0.0 | 0.0 |
| **LONG BEACH** | 0.7 | 1.1 | 0.0 | 0.2 | 0.5 | 0.0 | 0.7 | 0.5 | 0.4 |
| LOS ANGELES | 1.1 | 0.7 | 0.7 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| MADERA | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MARIN | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.8 | 0.4 |
| MENDOCINO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.9 | 0.0 | 0.0 |
| MERCED | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 |
| MONO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.4 | 0.0 | 0.0 | 0.0 |
| MONTEREY | 0.6 | 0.3 | 1.1 | 0.0 | 0.0 | 0.3 | 0.0 | 0.8 | 0.3 |
| NAPA | 0.0 | 0.9 | 0.9 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| ORANGE | 0.5 | 0.6 | 0.4 | 0.4 | 0.4 | 0.3 | 0.6 | 0.4 | 0.2 |
| **PASADENA** | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.7 | 0.0 |
| PLACER | 0.6 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 |
| PLUMAS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.7 |
| RIVERSIDE | 0.1 | 0.3 | 0.2 | 0.1 | 0.2 | 0.4 | 0.2 | 0.4 | 0.0 |
| SACRAMENTO | 0.1 | 0.2 | 0.3 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.1 |
| SAN BENITO | 0.0 | 0.0 | 0.0 | 10.2 | 0.0 | 2.4 | 9.2 | 4.4 | 0.0 |
| SAN BERNARDINO | 0.5 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.5 | 0.2 |
| SAN DIEGO | 1.1 | 1.0 | 0.5 | 0.5 | 0.4 | 0.5 | 0.4 | 0.6 | 0.4 |
| SAN FRANCISCO | 1.1 | 0.8 | 0.3 | 0.4 | 0.7 | 0.5 | 0.7 | 0.1 | 0.6 |
| SAN JOAQUIN | 0.6 | 1.0 | 0.2 | 0.4 | 0.0 | 0.4 | 0.6 | 0.0 | 0.2 |
| SAN LUIS OBISPO | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 |
| SAN MATEO | 1.2 | 0.8 | 0.8 | 0.4 | 0.6 | 0.3 | 0.1 | 0.6 | 0.0 |
| SANTA BARBARA | 0.8 | 0.8 | 0.3 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.5 |
| SANTA CLARA | 1.6 | 0.7 | 0.9 | 0.1 | 0.2 | 0.3 | 0.5 | 0.4 | 1.3 |
| SANTA CRUZ | 0.0 | 0.0 | 0.4 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| SOLANO | 2.1 | 0.0 | 0.6 | 0.3 | 0.0 | 0.5 | 0.0 | 0.3 | 0.0 |
| SONOMA | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| STANISLAUS | 0.5 | 0.5 | 0.5 | 0.0 | 0.2 | 0.5 | 0.0 | 0.0 | 0.2 |
| SUTTER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 1.3 |
| TEHAMA | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TULARE | 1.9 | 0.9 | 0.3 | 0.3 | 0.6 | 0.3 | 0.0 | 0.3 | 0.0 |
| VENTURA | 1.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.3 | 0.1 | 0.4 |
| YOLO | 0.7 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 |
| YUBA | 0.0 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table E-7a Reported Incidence of Shigellosis Type D in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 95 | 69 | 69 | 97 | 88 | 93 | 89 | 77 | 80 |
| AMADOR | | | | | | 1 | | | |
| BERKELEY | 12 | 12 | 6 | 9 | 5 | 4 | 6 | 5 | 2 |
| BUTTE | 3 | 13 | 10 | 33 | 7 | 7 | | 1 | |
| CALAVERAS | | | | 2 | 1 | | | | 1 |
| COLUSA | | | | 1 | | 3 | | 1 | 3 |
| CONTRA COSTA | 34 | 1 | 23 | 58 | 40 | 62 | 16 | 32 | 29 |
| DEL NORTE | | | 1 | | | | | | |
| EL DORADO | 1 | | 3 | 4 | 4 | 2 | | 2 | 1 |
| FRESNO | 56 | 37 | 79 | 39 | 37 | 112 | 106 | 36 | 30 |
| GLENN | 5 | | 4 | 3 | | 1 | | | |
| HUMBOLDT | | 2 | | 4 | 4 | | 1 | 12 | 2 |
| IMPERIAL | 12 | 4 | 10 | 28 | 6 | 28 | 11 | 5 | 1 |
| INYO | | | 2 | | | 3 | | | 1 |
| KERN | 25 | 18 | 20 | 12 | 8 | 20 | 16 | 4 | 5 |
| KINGS | 3 | 3 | | 6 | | 3 | 7 | 7 | |
| LAKE | 1 | 1 | | 2 | 1 | | | | 1 |
| LASSEN | | | | | | | | | 2 |
| LONG BEACH | 52 | 33 | 55 | 102 | 30 | 64 | 46 | 61 | 42 |
| LOS ANGELES | 900 | 501 | 934 | 824 | 557 | 910 | 671 | 425 | 418 |
| MADERA | 5 | 2 | 15 | 14 | 5 | 11 | 10 | | 15 |
| MARIN | 16 | 9 | 9 | 12 | 6 | 16 | 4 | 9 | 9 |
| MARIPOSA | | | 2 | 1 | | | | | |
| MENDOCINO | 2 | 2 | | 3 | | 4 | 2 | | 55 |
| MERCED | 10 | 7 | 16 | 37 | 13 | 48 | 15 | 1 | 6 |
| MODOC | | | 3 | | | | | 1 | |
| MONO | | | 1 | | | 1 | | | 1 |
| MONTEREY | 6 | 10 | 16 | 19 | 4 | 30 | 12 | 8 | 18 |
| NAPA | 4 | 4 | 4 | 6 | 2 | 7 | 5 | 5 | 5 |
| NEVADA | 4 | | 1 | | | 1 | 2 | 3 | |
| ORANGE | 174 | 103 | 169 | 127 | 55 | 266 | 167 | 125 | 133 |
| PASADENA | 29 | 7 | 18 | 13 | 41 | 40 | 16 | 20 | 10 |
| PLACER | 6 | 3 | 9 | 10 | 2 | 2 | 1 | 3 | 2 |
| RIVERSIDE | 91 | 37 | 86 | 99 | 45 | 95 | 60 | 51 | 33 |
| SACRAMENTO | 50 | 27 | 72 | 187 | 85 | 42 | 36 | 43 | 66 |
| SAN BENITO | 3 | | 2 | 4 | 1 | 10 | 5 | 6 | 9 |
| SAN BERNARDINO | 99 | 74 | 61 | 130 | 108 | 175 | 75 | 62 | 35 |
| SAN DIEGO | 324 | 136 | 205 | 210 | 198 | 300 | 188 | 170 | 156 |
| SAN FRANCISCO | 129 | 89 | 183 | 110 | 103 | 223 | 160 | 96 | 50 |
| SAN JOAQUIN | 67 | 43 | 97 | 122 | 74 | 96 | 76 | 46 | 67 |
| SAN LUIS OBISPO | 16 | 8 | 15 | 5 | 1 | 3 | 1 | 3 | 5 |
| SAN MATEO | 56 | 59 | 66 | 105 | 60 | 113 | 58 | 51 | 61 |
| SANTA BARBARA | 30 | 13 | 29 | 13 | 5 | 20 | 11 | 10 | 28 |
| SANTA CLARA | 117 | 75 | 89 | 87 | 38 | 131 | 57 | 50 | 69 |
| SANTA CRUZ | 21 | 10 | 13 | 12 | 3 | 20 | 15 | 7 | 7 |
| SHASTA | 1 | 1 | 17 | 8 | 9 | 4 | 1 | | 4 |
| SISKIYOU | | | 1 | 5 | | | | | |
| SOLANO | 20 | 22 | 9 | 27 | 13 | 34 | 6 | 13 | 14 |
| SONOMA | 10 | 3 | 7 | 7 | 8 | 10 | 6 | 9 | 12 |
| STANISLAUS | 34 | 22 | 57 | 52 | 11 | 49 | 31 | 20 | 26 |
| SUTTER | 5 | 4 | 6 | 6 | 4 | 2 | | 2 | 2 |
| TEHAMA | | | | 3 | 1 | 1 | | | 1 |
| TRINITY | | | | | 1 | | | 1 | |
| TULARE | 43 | 22 | 59 | 73 | 27 | 41 | 18 | 10 | 9 |
| TUOLUMNE | | | | 1 | | 2 | | | |
| VENTURA | 55 | 21 | 48 | 28 | 20 | 26 | 9 | 9 | 39 |
| YOLO | 4 | 3 | 6 | 4 | 2 | 3 | 4 | 4 | 1 |
| YUBA | 2 | 12 | 1 | 4 | 4 | 5 | | 2 | |
| Grand Total | 2632 | 1522 | 2608 | 2768 | 1737 | 3144 | 2020 | 1508 | 1566 |

Table E-7b Reported Incidence of Shigellosis Type D in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 8.1 | 5.8 | 5.7 | 7.9 | 7.1 | 7.5 | 7.1 | 6.0 | 6.1 |
| AMADOR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.0 |
| BERKELEY | 11.7 | 11.6 | 5.8 | 8.6 | 4.8 | 3.8 | 5.7 | 4.7 | 1.9 |
| BUTTE | 1.6 | 7.0 | 5.3 | 17.3 | 3.6 | 3.6 | 0.0 | 0.5 | 0.0 |
| CALAVERAS | 0.0 | 0.0 | 0.0 | 5.7 | 2.8 | 0.0 | 0.0 | 0.0 | 2.6 |
| COLUSA | 0.0 | 0.0 | 0.0 | 5.8 | 0.0 | 16.9 | 0.0 | 5.4 | 16.1 |
| CONTRA COSTA | 4.2 | 0.1 | 2.8 | 6.9 | 4.7 | 7.2 | 1.8 | 3.6 | 3.2 |
| DEL NORTE | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| EL DORADO | 0.8 | 0.0 | 2.2 | 2.9 | 2.8 | 1.4 | 0.0 | 1.4 | 0.7 |
| FRESNO | 8.4 | 5.4 | 11.2 | 5.4 | 5.0 | 15.0 | 13.9 | 4.6 | 3.8 |
| GLENN | 20.2 | 0.0 | 15.6 | 11.6 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 |
| HUMBOLDT | 0.0 | 1.7 | 0.0 | 3.2 | 3.2 | 0.0 | 0.8 | 9.6 | 1.6 |
| IMPERIAL | 11.0 | 3.5 | 8.4 | 22.2 | 4.5 | 20.7 | 7.9 | 3.5 | 0.7 |
| INYO | 0.0 | 0.0 | 10.9 | 0.0 | 0.0 | 16.3 | 0.0 | 0.0 | 5.5 |
| KERN | 4.6 | 3.2 | 3.5 | 2.0 | 1.3 | 3.3 | 2.6 | 0.6 | 0.8 |
| KINGS | 3.0 | 2.9 | 0.0 | 5.5 | 0.0 | 2.6 | 6.1 | 6.0 | 0.0 |
| LAKE | 2.0 | 1.9 | 0.0 | 3.7 | 1.8 | 0.0 | 0.0 | 0.0 | 1.8 |
| LASSEN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.9 |
| LONG BEACH | 12.1 | 7.5 | 12.4 | 23.2 | 6.8 | 14.6 | 10.5 | 13.8 | 9.4 |
| LOS ANGELES | 10.8 | 6.0 | 11.0 | 9.5 | 6.4 | 10.4 | 7.6 | 4.8 | 4.6 |
| MADERA | 5.7 | 2.2 | 15.6 | 14.0 | 4.8 | 10.4 | 9.2 | 0.0 | 13.1 |
| MARIN | 7.0 | 3.9 | 3.8 | 5.1 | 2.5 | 6.7 | 1.7 | 3.7 | 3.7 |
| MARIPOSA | 0.0 | 0.0 | 13.2 | 6.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MENDOCINO | 2.5 | 2.5 | 0.0 | 3.6 | 0.0 | 4.8 | 2.4 | 0.0 | 63.9 |
| MERCED | 5.6 | 3.8 | 8.5 | 19.3 | 6.6 | 24.3 | 7.6 | 0.5 | 3.0 |
| MODOC | 0.0 | 0.0 | 30.4 | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 0.0 |
| MONO | 0.0 | 0.0 | 10.0 | 0.0 | 0.0 | 9.4 | 0.0 | 0.0 | 9.5 |
| MONTEREY | 1.7 | 2.8 | 4.4 | 5.1 | 1.1 | 8.3 | 3.3 | 2.2 | 4.7 |
| NAPA | 3.6 | 3.6 | 3.5 | 5.2 | 1.7 | 6.0 | 4.2 | 4.2 | 4.1 |
| NEVADA | 5.1 | 0.0 | 1.2 | 0.0 | 0.0 | 1.2 | 2.3 | 3.4 | 0.0 |
| ORANGE | 7.2 | 4.2 | 6.8 | 5.0 | 2.1 | 10.2 | 6.3 | 4.7 | 4.9 |
| PASADENA | 22.0 | 5.3 | 13.5 | 9.6 | 30.3 | 29.3 | 11.7 | 14.4 | 7.1 |
| PLACER | 3.5 | 1.7 | 4.9 | 5.3 | 1.0 | 1.0 | 0.5 | 1.4 | 0.9 |
| RIVERSIDE | 7.8 | 3.0 | 6.8 | 7.6 | 3.4 | 7.0 | 4.3 | 3.6 | 2.3 |
| SACRAMENTO | 4.8 | 2.5 | 6.6 | 17.0 | 7.7 | 3.8 | 3.2 | 3.8 | 5.7 |
| SAN BENITO | 8.2 | 0.0 | 5.2 | 10.2 | 2.5 | 24.0 | 11.5 | 13.3 | 19.2 |
| SAN BERNARDINO | 7.0 | 5.1 | 4.0 | 8.4 | 6.9 | 11.1 | 4.7 | 3.9 | 2.1 |
| SAN DIEGO | 13.0 | 5.4 | 7.9 | 8.0 | 7.5 | 11.3 | 7.0 | 6.2 | 5.6 |
| SAN FRANCISCO | 17.8 | 12.2 | 24.9 | 14.8 | 13.7 | 29.7 | 21.1 | 12.4 | 6.4 |
| SAN JOAQUIN | 13.9 | 8.8 | 19.4 | 24.1 | 14.4 | 18.5 | 14.4 | 8.6 | 12.3 |
| SAN LUIS OBISPO | 7.4 | 3.7 | 6.8 | 2.2 | 0.4 | 1.3 | 0.4 | 1.3 | 2.1 |
| SAN MATEO | 8.6 | 9.0 | 9.9 | 15.6 | 8.8 | 16.5 | 8.4 | 7.2 | 8.5 |
| SANTA BARBARA | 8.1 | 3.5 | 7.6 | 3.4 | 1.3 | 5.1 | 2.8 | 2.5 | 6.9 |
| SANTA CLARA | 7.8 | 4.9 | 5.8 | 5.6 | 2.4 | 8.2 | 3.5 | 3.0 | 4.1 |
| SANTA CRUZ | 9.1 | 4.3 | 5.6 | 5.1 | 1.3 | 8.3 | 6.2 | 2.9 | 2.8 |
| SHASTA | 0.7 | 0.7 | 11.0 | 5.1 | 5.7 | 2.5 | 0.6 | 0.0 | 2.4 |
| SISKIYOU | 0.0 | 0.0 | 2.3 | 11.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SOLANO | 5.9 | 6.3 | 2.5 | 7.4 | 3.5 | 9.2 | 1.6 | 3.5 | 3.7 |
| SONOMA | 2.6 | 0.8 | 1.7 | 1.7 | 1.9 | 2.4 | 1.4 | 2.1 | 2.7 |
| STANISLAUS | 9.2 | 5.8 | 14.5 | 13.0 | 2.7 | 11.9 | 7.5 | 4.7 | 6.1 |
| SUTTER | 7.8 | 6.0 | 8.8 | 8.6 | 5.6 | 2.7 | 0.0 | 2.7 | 2.6 |
| TEHAMA | 0.0 | 0.0 | 0.0 | 5.7 | 1.9 | 1.9 | 0.0 | 0.0 | 1.8 |
| TRINITY | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | 0.0 | 0.0 | 7.5 | 0.0 |
| TULARE | 13.8 | 6.9 | 18.0 | 21.8 | 7.9 | 11.8 | 5.1 | 2.8 | 2.5 |
| TUOLUMNE | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 3.9 | 0.0 | 0.0 | 0.0 |
| VENTURA | 8.2 | 3.1 | 7.0 | 4.0 | 2.8 | 3.7 | 1.3 | 1.2 | 5.3 |
| YOLO | 2.8 | 2.1 | 4.1 | 2.7 | 1.4 | 2.0 | 2.6 | 2.6 | 0.6 |
| YUBA | 3.4 | 20.2 | 1.7 | 6.5 | 6.5 | 8.1 | 0.0 | 3.3 | 0.0 |

Table E-8a Reported Incidence of Shigellosis Type Unknown in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 57 | 15 | 17 | 57 | 57 | 29 | 28 | | 5 |
| AMADOR | 1 | | 1 | | | 1 | | | 1 |
| BERKELEY | 2 | 6 | 6 | 5 | 1 | | 4 | 3 | 1 |
| BUTTE | 9 | 17 | 20 | 14 | 7 | 4 | 4 | 6 | 2 |
| CALAVERAS | 1 | | | 1 | | 1 | | | |
| COLUSA | 1 | | 1 | | | | | 1 | |
| CONTRA COSTA | 37 | 72 | 5 | 14 | 23 | 18 | 5 | 12 | 18 |
| DEL NORTE | 2 | 9 | | 3 | | | | | |
| EL DORADO | 1 | | 2 | 2 | 3 | 2 | 5 | | 1 |
| FRESNO | 13 | 19 | 17 | 8 | 16 | 23 | 3 | 4 | 24 |
| GLENN | | 1 | | 1 | | | | | |
| HUMBOLDT | 3 | 1 | 1 | 2 | | 2 | 2 | 18 | 16 |
| IMPERIAL | 16 | 8 | 17 | 17 | 3 | 11 | 24 | 46 | 17 |
| INYO | | 2 | | 1 | | 3 | | | 1 |
| KERN | 32 | 56 | 60 | 57 | 68 | 72 | 73 | 74 | 66 |
| KINGS | 1 | | | | | | 3 | 2 | 2 |
| LAKE | 1 | 1 | | | | | | 1 | 1 |
| LASSEN | | | 1 | | | | | 3 | |
| LONG BEACH | 9 | 5 | 1 | 8 | 3 | 4 | 4 | | 3 |
| LOS ANGELES | 218 | 176 | 230 | 178 | 194 | 255 | 168 | 95 | 115 |
| MADERA | 5 | | 1 | | 1 | | 9 | 9 | 9 |
| MARIN | 2 | 5 | 1 | 2 | 1 | 1 | 5 | 2 | 1 |
| MENDOCINO | | | 2 | 1 | | 4 | 5 | 1 | 3 |
| MERCED | 25 | 16 | 18 | 14 | 23 | 19 | 8 | 5 | 6 |
| MODOC | | 1 | | | | | 2 | | |
| MONTEREY | 32 | 7 | 23 | 19 | 10 | 36 | 22 | 14 | 18 |
| NAPA | | | | 1 | 2 | 3 | 1 | | 2 |
| NEVADA | 1 | 2 | | 1 | 1 | | | | |
| ORANGE | 8 | 9 | 15 | 3 | 8 | 1 | | 2 | 1 |
| PASADENA | 1 | 1 | 3 | | | 1 | 1 | 2 | |
| PLACER | | | | | | 1 | 2 | | 2 |
| RIVERSIDE | 38 | 49 | 51 | 21 | 34 | 65 | 20 | 33 | 35 |
| SACRAMENTO | 11 | 13 | 10 | 22 | 9 | 10 | 9 | 13 | 5 |
| SAN BENITO | 5 | 2 | | | 3 | 1 | 1 | | |
| SAN BERNARDINO | 22 | 6 | 17 | 38 | 18 | 29 | 18 | 18 | 12 |
| SAN DIEGO | 52 | 45 | 48 | 55 | 46 | 46 | 55 | 60 | 48 |
| SAN FRANCISCO | 2 | 2 | 3 | 1 | | 2 | 1 | 1 | |
| SAN JOAQUIN | 4 | 19 | 23 | 13 | 2 | 5 | | | 1 |
| SAN LUIS OBISPO | 1 | 2 | 4 | | 1 | 1 | | | |
| SAN MATEO | 32 | 27 | 11 | 7 | 8 | 10 | 15 | 8 | 7 |
| SANTA BARBARA | | 3 | 5 | 4 | 7 | 11 | 8 | 4 | 8 |
| SANTA CLARA | 57 | 53 | 48 | 49 | 45 | 55 | 41 | 55 | 61 |
| SANTA CRUZ | 5 | 3 | 10 | 9 | 7 | 16 | 9 | 21 | 7 |
| SHASTA | | | | 4 | | | 1 | 1 | 2 |
| SISKIYOU | 4 | | | | 6 | 1 | | | |
| SOLANO | 6 | 2 | 1 | 3 | 4 | 8 | 5 | 4 | 12 |
| SONOMA | 18 | 12 | 10 | 22 | 14 | 28 | 19 | 22 | 17 |
| STANISLAUS | 1 | | | | | | | | |
| SUTTER | 1 | 2 | | | | 1 | 1 | | |
| TEHAMA | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | |
| TULARE | 7 | 7 | 9 | 11 | 9 | 7 | 23 | 19 | 26 |
| TUOLUMNE | 1 | | 1 | 1 | 1 | 2 | | | |
| VENTURA | 18 | 14 | 15 | 23 | 22 | 18 | 11 | 11 | 10 |
| YOLO | | 2 | 3 | 5 | 4 | 8 | 4 | 9 | 5 |
| YUBA | 9 | 17 | 4 | 2 | 3 | 1 | 1 | 1 | 1 |
| Grand Total | 773 | 711 | 717 | 701 | 666 | 817 | 621 | 581 | 572 |

Table E-8b Reported Incidence of Shigellosis Type Unknown in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 4.9 | 1.3 | 1.4 | 4.7 | 4.6 | 2.3 | 2.2 | 0.0 | 0.4 |
| AMADOR | 3.3 | 0.0 | 3.2 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 3.0 |
| **BERKELEY** | 1.9 | 5.8 | 5.8 | 4.8 | 1.0 | 0.0 | 3.8 | 2.8 | 0.9 |
| BUTTE | 4.9 | 9.2 | 10.6 | 7.4 | 3.6 | 2.1 | 2.0 | 3.0 | 1.0 |
| CALAVERAS | 3.1 | 0.0 | 0.0 | 2.8 | 0.0 | 2.7 | 0.0 | 0.0 | 0.0 |
| COLUSA | 6.1 | 0.0 | 5.9 | 0.0 | 0.0 | 0.0 | 0.0 | 5.4 | 0.0 |
| CONTRA COSTA | 4.6 | 8.8 | 0.6 | 1.7 | 2.7 | 2.1 | 0.6 | 1.4 | 2.0 |
| DEL NORTE | 8.5 | 35.7 | 0.0 | 11.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| EL DORADO | 0.8 | 0.0 | 1.5 | 1.5 | 2.1 | 1.4 | 3.5 | 0.0 | 0.7 |
| FRESNO | 1.9 | 2.8 | 2.4 | 1.1 | 2.2 | 3.1 | 0.4 | 0.5 | 3.1 |
| GLENN | 0.0 | 4.0 | 0.0 | 3.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HUMBOLDT | 2.5 | 0.8 | 0.8 | 1.6 | 0.0 | 1.6 | 1.6 | 14.3 | 12.7 |
| IMPERIAL | 14.6 | 7.0 | 14.3 | 13.4 | 2.3 | 8.1 | 17.2 | 32.6 | 11.9 |
| INYO | 0.0 | 10.9 | 0.0 | 5.4 | 0.0 | 16.3 | 0.0 | 0.0 | 5.5 |
| KERN | 5.9 | 10.0 | 10.4 | 9.6 | 11.3 | 11.7 | 11.8 | 11.8 | 10.4 |
| KINGS | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 1.7 | 1.7 |
| LAKE | 2.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 1.8 |
| LASSEN | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | 0.0 |
| **LONG BEACH** | 2.1 | 1.1 | 0.2 | 1.8 | 0.7 | 0.9 | 0.9 | 0.0 | 0.7 |
| LOS ANGELES | 2.6 | 2.1 | 2.7 | 2.1 | 2.2 | 2.9 | 1.9 | 1.1 | 1.3 |
| MADERA | 5.7 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 8.3 | 8.0 | 7.9 |
| MARIN | 0.9 | 2.2 | 0.4 | 0.8 | 0.4 | 0.4 | 2.1 | 0.8 | 0.4 |
| MENDOCINO | 0.0 | 0.0 | 2.4 | 1.2 | 0.0 | 4.8 | 5.9 | 1.2 | 3.5 |
| MERCED | 14.0 | 8.7 | 9.6 | 7.3 | 11.7 | 9.6 | 4.0 | 2.5 | 3.0 |
| MODOC | 0.0 | 10.2 | 0.0 | 0.0 | 0.0 | 0.0 | 19.9 | 0.0 | 0.0 |
| MONTEREY | 9.0 | 1.9 | 6.3 | 5.1 | 2.7 | 10.0 | 6.1 | 3.8 | 4.7 |
| NAPA | 0.0 | 0.0 | 0.0 | 0.9 | 1.7 | 2.6 | 0.8 | 0.0 | 1.6 |
| NEVADA | 1.3 | 2.5 | 0.0 | 1.2 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| ORANGE | 0.3 | 0.4 | 0.6 | 0.1 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 |
| **PASADENA** | 0.8 | 0.8 | 2.2 | 0.0 | 0.0 | 0.7 | 0.7 | 1.4 | 0.0 |
| PLACER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 1.0 | 0.0 | 0.9 |
| RIVERSIDE | 3.2 | 4.0 | 4.0 | 1.6 | 2.6 | 4.8 | 1.4 | 2.4 | 2.4 |
| SACRAMENTO | 1.1 | 1.2 | 0.9 | 2.0 | 0.8 | 0.9 | 0.8 | 1.1 | 0.4 |
| SAN BENITO | 13.6 | 5.4 | 0.0 | 0.0 | 7.4 | 2.4 | 2.3 | 0.0 | 0.0 |
| SAN BERNARDINO | 1.6 | 0.4 | 1.1 | 2.5 | 1.2 | 1.8 | 1.1 | 1.1 | 0.7 |
| SAN DIEGO | 2.1 | 1.8 | 1.9 | 2.1 | 1.7 | 1.7 | 2.1 | 2.2 | 1.7 |
| SAN FRANCISCO | 0.3 | 0.3 | 0.4 | 0.1 | 0.0 | 0.3 | 0.1 | 0.1 | 0.0 |
| SAN JOAQUIN | 0.8 | 3.9 | 4.6 | 2.6 | 0.4 | 1.0 | 0.0 | 0.0 | 0.2 |
| SAN LUIS OBISPO | 0.5 | 0.9 | 1.8 | 0.0 | 0.4 | 0.4 | 0.0 | 0.0 | 0.0 |
| SAN MATEO | 4.9 | 4.1 | 1.7 | 1.0 | 1.2 | 1.5 | 2.2 | 1.1 | 1.0 |
| SANTA BARBARA | 0.0 | 0.8 | 1.3 | 1.0 | 1.8 | 2.8 | 2.0 | 1.0 | 2.0 |
| SANTA CLARA | 3.8 | 3.5 | 3.1 | 3.1 | 2.8 | 3.4 | 2.5 | 3.3 | 3.6 |
| SANTA CRUZ | 2.2 | 1.3 | 4.3 | 3.8 | 2.9 | 6.7 | 3.7 | 8.6 | 2.8 |
| SHASTA | 0.0 | 0.0 | 0.0 | 2.5 | 0.0 | 0.0 | 0.6 | 0.6 | 1.2 |
| SISKIYOU | 9.2 | 0.0 | 0.0 | 0.0 | 13.5 | 2.2 | 0.0 | 0.0 | 0.0 |
| SOLANO | 1.8 | 0.6 | 0.3 | 0.8 | 1.1 | 2.2 | 1.3 | 1.1 | 3.1 |
| SONOMA | 4.6 | 3.0 | 2.5 | 5.4 | 3.4 | 6.7 | 4.5 | 5.1 | 3.9 |
| STANISLAUS | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SUTTER | 1.6 | 3.0 | 0.0 | 0.0 | 0.0 | 1.4 | 1.3 | 0.0 | 0.0 |
| TEHAMA | 2.0 | 4.0 | 3.9 | 3.8 | 3.8 | 1.9 | 1.8 | 1.8 | 0.0 |
| TULARE | 2.2 | 2.2 | 2.7 | 3.3 | 2.6 | 2.0 | 6.5 | 5.3 | 7.2 |
| TUOLUMNE | 2.1 | 0.0 | 2.0 | 2.0 | 1.9 | 3.9 | 0.0 | 0.0 | 0.0 |
| VENTURA | 2.7 | 2.1 | 2.2 | 3.3 | 3.1 | 2.5 | 1.5 | 1.5 | 1.4 |
| YOLO | 0.0 | 1.4 | 2.1 | 3.4 | 2.7 | 5.4 | 2.6 | 5.9 | 3.2 |
| YUBA | 15.5 | 28.6 | 6.6 | 3.3 | 4.9 | 1.6 | 1.6 | 1.6 | 1.6 |

Table E-9a Reported Incidence of Amoebiasis in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 74 | 34 | 32 | 45 | 23 | 20 | 31 | 67 | 29 |
| ALPINE | | | | | | 2 | | | |
| AMADOR | | | 1 | | | 1 | | 2 | |
| BERKELEY | 13 | 9 | 5 | 9 | 2 | 3 | 5 | 9 | 3 |
| BUTTE | | 1 | | 1 | 1 | 3 | 1 | 2 | 7 |
| CALAVERAS | | 1 | 1 | | 1 | | | | |
| COLUSA | 1 | | | 1 | | | | | |
| CONTRA COSTA | 12 | 13 | 6 | 14 | 16 | 10 | 9 | 11 | 7 |
| DEL NORTE | | | | 1 | | | | | |
| EL DORADO | 2 | | | | | 1 | | | |
| FRESNO | 4 | 4 | 3 | 8 | 3 | 2 | 2 | 2 | 3 |
| GLENN | 2 | | | | | | | | |
| HUMBOLDT | 1 | 1 | | | 1 | 1 | 2 | 2 | |
| IMPERIAL | | 1 | 3 | 1 | 1 | 3 | 1 | | |
| INYO | 1 | | 1 | | | 1 | | | |
| KERN | 6 | 8 | 12 | 10 | 8 | 1 | 2 | 4 | 4 |
| KINGS | 1 | | 3 | 4 | | 1 | | 1 | |
| LAKE | | 1 | | | 1 | 1 | | | |
| LASSEN | | | | | | | | 1 | 1 |
| LONG BEACH | 10 | 24 | 20 | 21 | 14 | 13 | 16 | 13 | 14 |
| LOS ANGELES | 446 | 361 | 250 | 306 | 220 | 186 | 204 | 173 | 167 |
| MADERA | 1 | 1 | | 2 | | 1 | | | |
| MARIN | 33 | 38 | 26 | 31 | 36 | 41 | 30 | 26 | 22 |
| MARIPOSA | | | | 1 | | 1 | 1 | | |
| MENDOCINO | 2 | 1 | | | | 2 | 1 | | |
| MERCED | 3 | 10 | 20 | 8 | 11 | 10 | 2 | 3 | 3 |
| MODOC | | | | 1 | | | | | |
| MONO | | | | | | | | | 1 |
| MONTEREY | 18 | 8 | 2 | 6 | 5 | | 1 | 2 | 4 |
| NAPA | 5 | 3 | 4 | 1 | 5 | 4 | 1 | 3 | 6 |
| NEVADA | | | | | 1 | 1 | | | 1 |
| ORANGE | 110 | 81 | 123 | 93 | 50 | 48 | 36 | 41 | 26 |
| PASADENA | 5 | 8 | 4 | 3 | 1 | | | 2 | |
| PLACER | | 4 | 2 | 1 | 2 | 2 | 1 | 2 | |
| PLUMAS | | | 1 | | | | | | |
| RIVERSIDE | 15 | 18 | 14 | 9 | 7 | 6 | 15 | 7 | 12 |
| SACRAMENTO | 21 | 22 | 3 | 3 | 2 | 6 | 6 | 3 | 4 |
| SAN BENITO | | 1 | 1 | 2 | | | | 1 | |
| SAN BERNARDINO | 14 | 19 | 16 | 21 | 21 | 11 | 11 | 12 | 6 |
| SAN DIEGO | 26 | 21 | 37 | 37 | 49 | 62 | 62 | 82 | 27 |
| SAN FRANCISCO | 315 | 293 | 195 | 259 | 255 | 282 | 172 | 296 | 187 |
| SAN JOAQUIN | 22 | 41 | 34 | 18 | 7 | 5 | 4 | 6 | 13 |
| SAN LUIS OBISPO | 8 | 2 | 2 | 6 | 1 | 4 | 4 | 1 | 4 |
| SAN MATEO | 37 | 40 | 25 | 16 | 26 | 10 | 16 | 27 | 19 |
| SANTA BARBARA | 84 | 36 | 58 | 42 | 59 | 28 | 96 | 60 | 55 |
| SANTA CLARA | 238 | 132 | 111 | 94 | 90 | 96 | 52 | 44 | 47 |
| SANTA CRUZ | 13 | 10 | 11 | 3 | 12 | 5 | 1 | 4 | 6 |
| SHASTA | 3 | | | | | 1 | | | |
| SISKIYOU | | 1 | | | | | | | 1 |
| SOLANO | 10 | 7 | 8 | 4 | 3 | 1 | 2 | | 2 |
| SONOMA | 32 | 27 | 16 | 15 | 12 | 12 | 16 | 4 | 5 |
| STANISLAUS | 28 | 24 | 38 | 35 | 15 | 15 | 7 | 5 | 1 |
| SUTTER | 8 | 2 | 3 | 3 | 1 | 1 | | 1 | |
| TEHAMA | | | | | 1 | | 1 | | |
| TRINITY | 3 | | 1 | | | | | | |
| TULARE | 7 | 29 | 35 | 33 | 23 | 21 | 6 | 10 | 3 |
| TUOLUMNE | 1 | 2 | 1 | | | | | | |
| VENTURA | 10 | 3 | 6 | 7 | 4 | 6 | 1 | 2 | 4 |
| YOLO | 1 | 1 | 2 | 4 | | 1 | 4 | 1 | 3 |
| YUBA | | | | 3 | | 2 | | 1 | 1 |
| Grand Total | 1646 | 1343 | 1136 | 1182 | 990 | 934 | 822 | 933 | 698 |

Table E-9b Reported Incidence of Amoebiasis in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 6.3 | 2.9 | 2.7 | 3.7 | 1.9 | 1.6 | 2.5 | 5.3 | 2.2 |
| ALPINE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 175.4 | 0.0 | 0.0 | 0.0 |
| AMADOR | 0.0 | 0.0 | 3.2 | 0.0 | 0.0 | 3.1 | 0.0 | 6.0 | 0.0 |
| **BERKELEY** | 12.7 | 8.7 | 4.8 | 8.6 | 1.9 | 2.9 | 4.8 | 8.5 | 2.8 |
| BUTTE | 0.0 | 0.5 | 0.0 | 0.5 | 0.5 | 1.5 | 0.5 | 1.0 | 3.5 |
| CALAVERAS | 0.0 | 3.0 | 2.9 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| COLUSA | 6.1 | 0.0 | 0.0 | 5.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CONTRA COSTA | 1.5 | 1.6 | 0.7 | 1.7 | 1.9 | 1.2 | 1.0 | 1.2 | 0.8 |
| DEL NORTE | 0.0 | 0.0 | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| EL DORADO | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 |
| FRESNO | 0.6 | 0.6 | 0.4 | 1.1 | 0.4 | 0.3 | 0.3 | 0.3 | 0.4 |
| GLENN | 8.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HUMBOLDT | 0.8 | 0.8 | 0.0 | 0.0 | 0.8 | 0.8 | 1.6 | 1.6 | 0.0 |
| IMPERIAL | 0.0 | 0.9 | 2.5 | 0.8 | 0.8 | 2.2 | 0.7 | 0.0 | 0.0 |
| INYO | 5.5 | 0.0 | 5.5 | 0.0 | 0.0 | 5.4 | 0.0 | 0.0 | 0.0 |
| KERN | 1.1 | 1.4 | 2.1 | 1.7 | 1.3 | 0.2 | 0.3 | 0.6 | 0.6 |
| KINGS | 1.0 | 0.0 | 2.8 | 3.6 | 0.0 | 0.9 | 0.0 | 0.9 | 0.0 |
| LAKE | 0.0 | 1.9 | 0.0 | 0.0 | 1.8 | 1.8 | 0.0 | 0.0 | 0.0 |
| LASSEN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 3.0 |
| **LONG BEACH** | 2.3 | 5.5 | 4.5 | 4.8 | 3.2 | 3.0 | 3.7 | 2.9 | 3.1 |
| LOS ANGELES | 5.4 | 4.3 | 2.9 | 3.5 | 2.5 | 2.1 | 2.3 | 1.9 | 1.9 |
| MADERA | 1.1 | 1.1 | 0.0 | 2.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |
| MARIN | 14.3 | 16.4 | 11.1 | 13.1 | 15.2 | 17.2 | 12.5 | 10.8 | 9.0 |
| MARIPOSA | 0.0 | 0.0 | 0.0 | 6.4 | 0.0 | 6.3 | 6.3 | 0.0 | 0.0 |
| MENDOCINO | 2.5 | 1.2 | 0.0 | 0.0 | 0.0 | 2.4 | 1.2 | 0.0 | 0.0 |
| MERCED | 1.7 | 5.4 | 10.6 | 4.2 | 5.6 | 5.1 | 1.0 | 1.5 | 1.5 |
| MODOC | 0.0 | 0.0 | 0.0 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MONO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.5 |
| MONTEREY | 5.1 | 2.2 | 0.5 | 1.6 | 1.4 | 0.0 | 0.3 | 0.5 | 1.0 |
| NAPA | 4.5 | 2.7 | 3.5 | 0.9 | 4.3 | 3.4 | 0.8 | 2.5 | 4.9 |
| NEVADA | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.2 | 0.0 | 0.0 | 1.1 |
| ORANGE | 4.6 | 3.3 | 4.9 | 3.7 | 1.9 | 1.8 | 1.4 | 1.5 | 1.0 |
| **PASADENA** | 3.8 | 6.0 | 3.0 | 2.2 | 0.7 | 0.0 | 0.0 | 1.4 | 0.0 |
| PLACER | 0.0 | 2.2 | 1.1 | 0.5 | 1.0 | 1.0 | 0.5 | 0.9 | 0.0 |
| PLUMAS | 0.0 | 0.0 | 4.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| RIVERSIDE | 1.3 | 1.5 | 1.1 | 0.7 | 0.5 | 0.4 | 1.1 | 0.5 | 0.8 |
| SACRAMENTO | 2.0 | 2.1 | 0.3 | 0.3 | 0.2 | 0.5 | 0.5 | 0.3 | 0.3 |
| SAN BENITO | 0.0 | 2.7 | 2.6 | 5.1 | 0.0 | 0.0 | 0.0 | 2.2 | 0.0 |
| SAN BERNARDINO | 1.0 | 1.3 | 1.1 | 1.4 | 1.3 | 0.7 | 0.7 | 0.7 | 0.4 |
| SAN DIEGO | 1.0 | 0.8 | 1.4 | 1.4 | 1.9 | 2.3 | 2.3 | 3.0 | 1.0 |
| SAN FRANCISCO | 43.5 | 40.1 | 26.5 | 34.8 | 33.9 | 37.5 | 22.6 | 38.3 | 23.9 |
| SAN JOAQUIN | 4.6 | 8.4 | 6.8 | 3.5 | 1.4 | 1.0 | 0.8 | 1.1 | 2.4 |
| SAN LUIS OBISPO | 3.7 | 0.9 | 0.9 | 2.7 | 0.4 | 1.8 | 1.7 | 0.4 | 1.7 |
| SAN MATEO | 5.7 | 6.1 | 3.8 | 2.4 | 3.8 | 1.5 | 2.3 | 3.8 | 2.7 |
| SANTA BARBARA | 22.7 | 9.6 | 15.3 | 11.0 | 15.3 | 7.2 | 24.5 | 15.1 | 13.7 |
| SANTA CLARA | 15.9 | 8.7 | 7.2 | 6.0 | 5.7 | 6.0 | 3.2 | 2.7 | 2.8 |
| SANTA CRUZ | 5.7 | 4.3 | 4.7 | 1.3 | 5.0 | 2.1 | 0.4 | 1.6 | 2.4 |
| SHASTA | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 |
| SISKIYOU | 0.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 |
| SOLANO | 2.9 | 2.0 | 2.2 | 1.1 | 0.8 | 0.3 | 0.5 | 0.0 | 0.5 |
| SONOMA | 8.2 | 6.8 | 4.0 | 3.7 | 2.9 | 2.9 | 3.8 | 0.9 | 1.1 |
| STANISLAUS | 7.6 | 6.3 | 9.7 | 8.7 | 3.7 | 3.6 | 1.7 | 1.2 | 0.2 |
| SUTTER | 12.4 | 3.0 | 4.4 | 4.3 | 1.4 | 1.4 | 0.0 | 1.3 | 0.0 |
| TEHAMA | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 | 1.8 | 0.0 | 0.0 |
| TRINITY | 23.0 | 0.0 | 7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TULARE | 2.2 | 9.1 | 10.7 | 9.9 | 6.7 | 6.1 | 1.7 | 2.8 | 0.8 |
| TUOLUMNE | 2.1 | 4.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| VENTURA | 1.5 | 0.4 | 0.9 | 1.0 | 0.6 | 0.8 | 0.1 | 0.3 | 0.5 |
| YOLO | 0.7 | 0.7 | 1.4 | 2.7 | 0.0 | 0.7 | 2.6 | 0.7 | 1.9 |
| YUBA | 0.0 | 0.0 | 0.0 | 4.9 | 0.0 | 3.2 | 0.0 | 1.6 | 1.6 |

Table E-10a Reported Incidence of Cryptosporidosis in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | | 1 | 2 | 1 | | 3 | 8 | 8 | 29 |
| AMADOR | | | | | | | | | 1 |
| BERKELEY | 1 | 1 | 1 | 2 | 1 | | 1 | 4 | 4 |
| BUTTE | | | | | 1 | | | | 3 |
| CONTRA COSTA | 1 | 3 | 6 | 5 | 3 | 1 | 3 | 11 | 15 |
| DEL NORTE | | | 1 | | | | | | |
| EL DORADO | 1 | | | | | | | | 2 |
| FRESNO | | 2 | 1 | 2 | 1 | 2 | 36 | 2 | 6 |
| GLENN | | | | | | | | 1 | |
| HUMBOLDT | | 1 | 2 | | | 2 | | 2 | 1 |
| IMPERIAL | | | | | | | 2 | 1 | |
| INYO | | | | | | | | | 1 |
| KERN | | 1 | | 1 | 7 | 5 | 9 | 4 | |
| LASSEN | | | | | | | 2 | | 2 |
| LONG BEACH | | 5 | 10 | 18 | 17 | 24 | 10 | 4 | 3 |
| LOS ANGELES | 3 | 10 | 108 | 96 | 202 | 214 | 177 | 81 | 103 |
| MADERA | | | | 1 | | | 2 | | |
| MARIN | 2 | 4 | 4 | | 2 | 2 | 3 | 10 | 9 |
| MARIPOSA | | | | 1 | | | | | |
| MENDOCINO | | | | | 2 | 1 | | | |
| MODOC | | | | | | | | 1 | |
| MONTEREY | 2 | | | | | 1 | 3 | 5 | 2 |
| NAPA | 1 | 1 | | | | 1 | 1 | 2 | 2 |
| NEVADA | | | | | | 1 | 1 | | 5 |
| ORANGE | 15 | 15 | 18 | 20 | 8 | 28 | 9 | 13 | 21 |
| PASADENA | | | | | 4 | 1 | 2 | 1 | 1 |
| PLACER | | | | | | | | | 1 |
| RIVERSIDE | 1 | 2 | 8 | 4 | 9 | 12 | 9 | 1 | 9 |
| SACRAMENTO | 1 | | 1 | | 1 | 3 | 7 | 7 | 7 |
| SAN BERNARDINO | 11 | 1 | 5 | 15 | 14 | 12 | 11 | 4 | 4 |
| SAN DIEGO | 2 | 6 | 12 | 46 | 64 | 60 | 45 | 24 | 41 |
| SAN FRANCISCO | 116 | 144 | 85 | 138 | 118 | 125 | 84 | 66 | 27 |
| SAN JOAQUIN | | 1 | 1 | 2 | 7 | 1 | | 1 | 4 |
| SAN LUIS OBISPO | | 1 | 1 | 1 | 1 | | 2 | | |
| SAN MATEO | 4 | 7 | 3 | 2 | 1 | 2 | 5 | 7 | 7 |
| SANTA BARBARA | | | | | | 1 | 1 | 1 | 5 |
| SANTA CLARA | 2 | 2 | 7 | 3 | 7 | 5 | 16 | 20 | 14 |
| SANTA CRUZ | 2 | | | 2 | 2 | | 1 | 4 | 4 |
| SHASTA | | | | 1 | | | | | 2 |
| SIERRA | | | | | | 1 | | | 1 |
| SISKIYOU | | | | | | | | 1 | |
| SOLANO | 1 | 1 | 3 | 4 | 1 | 6 | 2 | 14 | 13 |
| SONOMA | | 1 | | | 1 | 3 | 4 | 17 | 10 |
| STANISLAUS | | | | | 1 | | 2 | 2 | 1 |
| SUTTER | | | | | | | 4 | 1 | |
| TULARE | | | | | 1 | | | | 1 |
| VENTURA | | | 3 | 2 | 3 | 2 | 6 | 4 | 7 |
| YOLO | | | | | 1 | 2 | 1 | 3 | 4 |
| YUBA | | | | | | | 1 | 1 | |
| Grand Total | 166 | 210 | 282 | 367 | 480 | 521 | 470 | 328 | 372 |

Table E-10b Reported Incidence of Cryptosporidosis in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 0.0 | 0.1 | 0.2 | 0.1 | 0.0 | 0.2 | 0.6 | 0.6 | 2.2 |
| AMADOR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 |
| **BERKELEY** | 1.0 | 1.0 | 1.0 | 1.9 | 1.0 | 0.0 | 1.0 | 3.8 | 3.7 |
| BUTTE | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 1.5 |
| CONTRA COSTA | 0.1 | 0.4 | 0.7 | 0.6 | 0.4 | 0.1 | 0.3 | 1.2 | 1.7 |
| DEL NORTE | 0.0 | 0.0 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| EL DORADO | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 |
| FRESNO | 0.0 | 0.3 | 0.1 | 0.3 | 0.1 | 0.3 | 4.7 | 0.3 | 0.8 |
| GLENN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 | 0.0 |
| HUMBOLDT | 0.0 | 0.8 | 1.6 | 0.0 | 0.0 | 1.6 | 0.0 | 1.6 | 0.8 |
| IMPERIAL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.7 | 0.0 |
| INYO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 |
| KERN | 0.0 | 0.2 | 0.0 | 0.2 | 1.2 | 0.8 | 1.5 | 0.6 | 0.0 |
| LASSEN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.5 | 0.0 | 5.9 |
| **LONG BEACH** | 0.0 | 1.1 | 2.3 | 4.1 | 3.9 | 5.5 | 2.3 | 0.9 | 0.7 |
| LOS ANGELES | 0.0 | 0.1 | 1.3 | 1.1 | 2.3 | 2.4 | 2.0 | 0.9 | 1.1 |
| MADERA | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 |
| MARIN | 0.9 | 1.7 | 1.7 | 0.0 | 0.8 | 0.8 | 1.3 | 4.1 | 3.7 |
| MARIPOSA | 0.0 | 0.0 | 0.0 | 6.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MENDOCINO | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | 1.2 | 0.0 | 0.0 | 0.0 |
| MODOC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 0.0 |
| MONTEREY | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.8 | 1.4 | 0.5 |
| NAPA | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 | 0.9 | 0.8 | 1.7 | 1.6 |
| NEVADA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.2 | 0.0 | 5.6 |
| ORANGE | 0.6 | 0.6 | 0.7 | 0.8 | 0.3 | 1.1 | 0.3 | 0.5 | 0.8 |
| **PASADENA** | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 0.7 | 1.5 | 0.7 | 0.7 |
| PLACER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| RIVERSIDE | 0.1 | 0.2 | 0.6 | 0.3 | 0.7 | 0.9 | 0.7 | 0.1 | 0.6 |
| SACRAMENTO | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 | 0.3 | 0.6 | 0.6 | 0.6 |
| SAN BERNARDINO | 0.8 | 0.1 | 0.3 | 1.0 | 0.9 | 0.8 | 0.7 | 0.2 | 0.2 |
| SAN DIEGO | 0.1 | 0.2 | 0.5 | 1.8 | 2.4 | 2.3 | 1.7 | 0.9 | 1.5 |
| SAN FRANCISCO | 16.0 | 19.7 | 11.6 | 18.5 | 15.7 | 16.6 | 11.1 | 8.5 | 3.4 |
| SAN JOAQUIN | 0.0 | 0.2 | 0.2 | 0.4 | 1.4 | 0.2 | 0.0 | 0.2 | 0.7 |
| SAN LUIS OBISPO | 0.0 | 0.5 | 0.5 | 0.4 | 0.4 | 0.0 | 0.9 | 0.0 | 0.0 |
| SAN MATEO | 0.6 | 1.1 | 0.5 | 0.3 | 0.1 | 0.3 | 0.7 | 1.0 | 1.0 |
| SANTA BARBARA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 | 0.3 | 1.2 |
| SANTA CLARA | 0.1 | 0.1 | 0.5 | 0.2 | 0.4 | 0.3 | 1.0 | 1.2 | 0.8 |
| SANTA CRUZ | 0.9 | 0.0 | 0.0 | 0.8 | 0.8 | 0.0 | 0.4 | 1.6 | 1.6 |
| SHASTA | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 |
| SIERRA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.7 | 0.0 | 0.0 | 29.9 |
| SISKIYOU | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 0.0 |
| SOLANO | 0.3 | 0.3 | 0.8 | 1.1 | 0.3 | 1.6 | 0.5 | 3.7 | 3.4 |
| SONOMA | 0.0 | 0.3 | 0.0 | 0.0 | 0.2 | 0.7 | 0.9 | 4.0 | 2.3 |
| STANISLAUS | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.5 | 0.5 | 0.2 |
| SUTTER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.4 | 1.3 | 0.0 |
| TULARE | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.3 |
| VENTURA | 0.0 | 0.0 | 0.4 | 0.3 | 0.4 | 0.3 | 0.8 | 0.6 | 1.0 |
| YOLO | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 1.3 | 0.7 | 2.0 | 2.6 |
| YUBA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 | 1.6 | 0.0 |

Table E-11a Reported Incidence of Cryptosporidosis Type S in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 1 |
| BERKELEY | | | | | 1 | | | | |
| BUTTE | | | | 1 | | | | | |
| CALAVERAS | | | | | | | 1 | | |
| CONTRA COSTA | | 1 | 2 | 1 | 1 | 1 | 3 | 1 | 1 |
| FRESNO | | 1 | | | 1 | | | 5 | 2 |
| IMPERIAL | 1 | | | | | | 1 | 1 | |
| KERN | | 1 | 1 | | | 1 | | | 1 |
| LONG BEACH | 2 | 5 | 1 | 4 | 1 | 1 | 2 | | |
| LOS ANGELES | 59 | 58 | 61 | 57 | 43 | 26 | 33 | 36 | 23 |
| MARIN | | | | | 2 | 1 | | 1 | |
| MENDOCINO | | 1 | | | | | | 3 | |
| MERCED | | | | 3 | | 2 | | | |
| MONTEREY | 7 | 3 | 6 | 3 | 3 | 3 | | | |
| NAPA | | | | 1 | 1 | 1 | | | |
| ORANGE | 27 | 38 | 24 | 25 | 19 | 14 | 13 | 21 | 15 |
| PASADENA | | 1 | | 2 | | 1 | | 1 | |
| PLACER | | | | | 1 | | | | |
| RIVERSIDE | 2 | | 10 | 5 | 7 | 4 | 2 | 3 | 3 |
| SACRAMENTO | | | | 1 | | 1 | | | |
| SAN BENITO | | | | 1 | | 1 | | | |
| SAN BERNARDINO | 2 | 5 | 4 | 3 | 7 | 2 | 2 | 1 | 3 |
| SAN DIEGO | 9 | 9 | 16 | 8 | 8 | 13 | 10 | 12 | 13 |
| SAN FRANCISCO | 1 | | 2 | 3 | 4 | 2 | 3 | 4 | |
| SAN JOAQUIN | 2 | 2 | 3 | 2 | | | 2 | | |
| SAN LUIS OBISPO | 1 | 1 | 1 | 1 | | | 1 | 3 | |
| SAN MATEO | 4 | 2 | | 1 | | 3 | | 2 | |
| SANTA BARBARA | | 2 | 4 | 1 | | 4 | 1 | 1 | 1 |
| SANTA CLARA | 13 | 6 | 7 | 11 | 4 | 4 | 8 | 9 | 6 |
| SANTA CRUZ | 2 | | 1 | 1 | 1 | 1 | 1 | | 1 |
| SHASTA | | | | | | | | 1 | |
| SISKIYOU | | 1 | | | | | | | |
| SONOMA | 2 | 1 | 2 | 3 | 1 | | 1 | 1 | 5 |
| STANISLAUS | 4 | | 3 | 1 | 2 | | 2 | 2 | 2 |
| SUTTER | | | | | 5 | 2 | | 2 | 2 |
| TEHAMA | | | | | 1 | | | | |
| TULARE | | | | 2 | 1 | 1 | | 1 | 1 |
| TUOLUMNE | | | | | | | | 1 | |
| VENTURA | 4 | | 1 | 1 | 3 | 2 | 2 | 5 | 1 |
| YOLO | | 1 | | | | | 2 | | 1 |
| YUBA | 1 | | | | | | 1 | | |
| Grand Total | 145 | 141 | 150 | 144 | 118 | 93 | 94 | 119 | 83 |

Table E-11b Reported Incidence of Cryptosporidosis Type S in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 |
| **BERKELEY** | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| BUTTE | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CALAVERAS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 |
| CONTRA COSTA | 0.0 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 |
| FRESNO | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.6 | 0.3 |
| IMPERIAL | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.7 | 0.0 |
| KERN | 0.0 | 0.2 | 0.2 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.2 |
| **LONG BEACH** | 0.5 | 1.1 | 0.2 | 0.9 | 0.2 | 0.2 | 0.5 | 0.0 | 0.0 |
| LOS ANGELES | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 0.3 | 0.4 | 0.4 | 0.3 |
| MARIN | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.4 | 0.0 | 0.4 | 0.0 |
| MENDOCINO | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.5 | 0.0 |
| MERCED | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| MONTEREY | 2.0 | 0.8 | 1.6 | 0.8 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 |
| NAPA | 0.0 | 0.0 | 0.0 | 0.9 | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 |
| ORANGE | 1.1 | 1.6 | 1.0 | 1.0 | 0.7 | 0.5 | 0.5 | 0.8 | 0.5 |
| **PASADENA** | 0.0 | 0.8 | 0.0 | 1.5 | 0.0 | 0.7 | 0.0 | 0.7 | 0.0 |
| PLACER | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| RIVERSIDE | 0.2 | 0.0 | 0.8 | 0.4 | 0.5 | 0.3 | 0.1 | 0.2 | 0.2 |
| SACRAMENTO | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| SAN BENITO | 0.0 | 0.0 | 0.0 | 2.5 | 0.0 | 2.4 | 0.0 | 0.0 | 0.0 |
| SAN BERNARDINO | 0.1 | 0.3 | 0.3 | 0.2 | 0.4 | 0.1 | 0.1 | 0.1 | 0.2 |
| SAN DIEGO | 0.4 | 0.4 | 0.6 | 0.3 | 0.3 | 0.5 | 0.4 | 0.4 | 0.5 |
| SAN FRANCISCO | 0.1 | 0.0 | 0.3 | 0.4 | 0.5 | 0.3 | 0.4 | 0.5 | 0.0 |
| SAN JOAQUIN | 0.4 | 0.4 | 0.6 | 0.4 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 |
| SAN LUIS OBISPO | 0.5 | 0.5 | 0.5 | 0.4 | 0.0 | 0.0 | 0.4 | 1.3 | 0.0 |
| SAN MATEO | 0.6 | 0.3 | 0.0 | 0.1 | 0.0 | 0.4 | 0.0 | 0.3 | 0.0 |
| SANTA BARBARA | 0.0 | 0.5 | 1.1 | 0.3 | 0.0 | 1.0 | 0.3 | 0.3 | 0.2 |
| SANTA CLARA | 0.9 | 0.4 | 0.5 | 0.7 | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 |
| SANTA CRUZ | 0.9 | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.0 | 0.4 |
| SHASTA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 |
| SISKIYOU | 0.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SONOMA | 0.5 | 0.3 | 0.5 | 0.7 | 0.2 | 0.0 | 0.2 | 0.2 | 1.1 |
| STANISLAUS | 1.1 | 0.0 | 0.8 | 0.2 | 0.5 | 0.0 | 0.5 | 0.5 | 0.5 |
| SUTTER | 0.0 | 0.0 | 0.0 | 0.0 | 7.0 | 2.7 | 0.0 | 2.7 | 2.6 |
| TEHAMA | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| TULARE | 0.0 | 0.0 | 0.0 | 0.6 | 0.3 | 0.3 | 0.0 | 0.3 | 0.3 |
| TUOLUMNE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 |
| VENTURA | 0.6 | 0.0 | 0.1 | 0.1 | 0.4 | 0.3 | 0.3 | 0.7 | 0.1 |
| YOLO | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.6 |
| YUBA | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 |

Table E-12a Reported Incidence of Giardiasis S in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 301 | 217 | 305 | 239 | 149 | 153 | 152 | 270 | |
| ALPINE | | | 3 | | | 1 | | | |
| AMADOR | 4 | 7 | 11 | 4 | 14 | 9 | 8 | 4 | 8 |
| BERKELEY | 37 | 30 | 35 | 24 | 16 | 17 | 29 | 41 | 15 |
| BUTTE | 44 | 56 | 59 | 56 | 47 | 47 | 41 | 51 | 37 |
| CALAVERAS | 5 | 3 | 14 | 8 | 6 | 4 | 12 | 8 | 5 |
| COLUSA | 5 | 4 | 6 | 3 | 1 | 3 | 2 | 2 | 1 |
| CONTRA COSTA | 216 | 182 | 75 | 194 | 214 | 139 | 162 | 204 | 153 |
| DEL NORTE | 1 | 10 | 8 | 6 | 2 | 2 | 6 | 2 | |
| EL DORADO | 14 | 16 | 35 | 10 | 15 | 14 | 11 | 15 | 12 |
| FRESNO | 238 | 320 | 304 | 247 | 223 | 204 | 132 | 77 | 88 |
| GLENN | 4 | 6 | 14 | 5 | 3 | 5 | 5 | 4 | 1 |
| HUMBOLDT | 15 | 14 | 21 | 33 | 19 | 28 | 29 | 22 | 13 |
| IMPERIAL | 4 | 3 | 8 | 22 | 5 | 4 | 10 | 9 | 3 |
| INYO | 5 | 18 | 27 | 17 | 6 | 2 | | 2 | |
| KERN | 83 | 102 | 153 | 117 | 73 | 65 | 93 | 78 | 82 |
| KINGS | 13 | 29 | 11 | 31 | 5 | 2 | 4 | 12 | 8 |
| LAKE | 18 | 21 | 21 | 26 | 12 | 15 | 29 | 2 | 2 |
| LASSEN | 2 | 3 | 5 | 2 | 5 | 2 | 5 | 13 | 5 |
| LONG BEACH | 107 | 89 | 125 | 89 | 89 | 64 | 85 | 73 | 63 |
| LOS ANGELES | 1808 | 1635 | 1667 | 1671 | 1177 | 924 | 979 | 804 | 724 |
| MADERA | 3 | 6 | 16 | 5 | 12 | 11 | 8 | 7 | 3 |
| MARIN | 108 | 155 | 213 | 141 | 138 | 137 | 75 | 104 | 98 |
| MARIPOSA | 2 | 3 | 3 | 3 | | 1 | 2 | | 2 |
| MENDOCINO | 22 | 21 | 12 | 19 | 15 | 44 | 31 | 34 | 23 |
| MERCED | 111 | 102 | 111 | 84 | 102 | 41 | 65 | 36 | 34 |
| MODOC | 2 | 2 | 6 | 7 | 2 | 3 | 1 | 2 | 2 |
| MONO | 2 | 6 | 1 | 7 | 2 | 1 | 1 | 2 | 3 |
| MONTEREY | 81 | 53 | 35 | 40 | 30 | 41 | 30 | 25 | 38 |
| NAPA | 39 | 34 | 108 | 72 | 48 | 64 | 32 | 32 | 41 |
| NEVADA | 43 | 28 | 48 | 17 | 25 | 12 | 33 | 26 | 15 |
| ORANGE | 666 | 472 | 668 | 674 | 302 | 406 | 359 | 321 | 272 |
| PASADENA | 47 | 58 | 51 | 39 | 27 | 16 | 28 | 27 | 20 |
| PLACER | 39 | 51 | 46 | 44 | 29 | 40 | 57 | 52 | 48 |
| PLUMAS | 3 | 36 | 54 | 20 | 8 | 6 | 4 | 8 | 8 |
| RIVERSIDE | 166 | 162 | 167 | 196 | 98 | 122 | 108 | 103 | 91 |
| SACRAMENTO | 241 | 329 | 267 | 198 | 95 | 62 | 63 | 78 | 106 |
| SAN BENITO | 6 | 8 | 11 | 10 | 2 | 2 | 6 | 15 | 7 |
| SAN BERNARDINO | 178 | 161 | 201 | 223 | 209 | 128 | 123 | 135 | 98 |
| SAN DIEGO | 317 | 311 | 497 | 736 | 695 | 573 | 507 | 455 | 455 |
| SAN FRANCISCO | 332 | 289 | 263 | 347 | 405 | 410 | 405 | 384 | 360 |
| SAN JOAQUIN | 295 | 266 | 297 | 196 | 249 | 195 | 178 | 114 | 99 |
| SAN LUIS OBISPO | 98 | 46 | 47 | 95 | 47 | 36 | 51 | 58 | 51 |
| SAN MATEO | 199 | 171 | 191 | 172 | 142 | 146 | 133 | 134 | 103 |
| SANTA BARBARA | 163 | 145 | 242 | 145 | 200 | 142 | 245 | 180 | 183 |
| SANTA CLARA | 651 | 545 | 556 | 616 | 554 | 511 | 452 | 369 | 307 |
| SANTA CRUZ | 50 | 37 | 110 | 29 | 39 | 45 | 34 | 35 | 34 |
| SHASTA | 19 | 21 | 24 | 27 | 31 | 14 | 4 | 9 | 8 |
| SIERRA | | | 4 | 4 | 1 | 2 | 1 | | 2 |
| SISKIYOU | 11 | 15 | 15 | 8 | 14 | 3 | 3 | 16 | 4 |
| SOLANO | 73 | 42 | 58 | 67 | 62 | 66 | 52 | 46 | 65 |
| SONOMA | 122 | 107 | 157 | 136 | 108 | 124 | 131 | 70 | 67 |
| STANISLAUS | 144 | 134 | 121 | 117 | 92 | 91 | 68 | 50 | 28 |
| SUTTER | 28 | 19 | 22 | 19 | 26 | 27 | 21 | 14 | 11 |
| TEHAMA | 5 | 9 | 7 | 6 | 11 | 7 | 9 | 6 | 4 |
| TRINITY | 6 | 8 | 23 | 7 | 7 | 9 | 3 | 2 | 1 |
| TULARE | 39 | 41 | 103 | 66 | 67 | 89 | 59 | 34 | 44 |
| TUOLUMNE | 18 | 7 | 2 | 3 | 2 | 2 | 5 | 1 | 6 |
| VENTURA | 184 | 163 | 126 | 98 | 77 | 42 | 62 | 43 | 36 |
| YOLO | 29 | 47 | 44 | 43 | 25 | 33 | 50 | 33 | 25 |
| YUBA | 16 | 14 | 16 | 17 | 32 | 16 | 13 | 13 | 7 |
| Grand Total | 7498 | 6889 | 7850 | 7557 | 6111 | 5424 | 5306 | 4766 | 4029 |

Table E-12b Reported Incidence of Giardiasis S in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 25.6 | 18.2 | 25.3 | 19.6 | 12.1 | 12.3 | 12.1 | 21.2 | 0.0 |
| ALPINE | 0.0 | 0.0 | 265.5 | 0.0 | 0.0 | 87.7 | 0.0 | 0.0 | 0.0 |
| AMADOR | 13.3 | 22.7 | 35.0 | 12.5 | 43.2 | 27.7 | 24.4 | 12.0 | 24.0 |
| **BERKELEY** | 36.0 | 29.0 | 33.6 | 23.0 | 15.3 | 16.3 | 27.7 | 38.6 | 13.9 |
| BUTTE | 24.2 | 30.3 | 31.4 | 29.4 | 24.4 | 24.1 | 20.9 | 25.8 | 18.6 |
| CALAVERAS | 15.6 | 9.1 | 40.7 | 22.6 | 16.6 | 10.9 | 32.5 | 21.6 | 13.1 |
| COLUSA | 30.7 | 24.1 | 35.5 | 17.4 | 5.7 | 16.9 | 11.1 | 10.9 | 5.4 |
| CONTRA COSTA | 26.9 | 22.3 | 9.0 | 23.0 | 25.0 | 16.1 | 18.6 | 23.0 | 16.9 |
| DEL NORTE | 4.3 | 39.7 | 30.2 | 22.2 | 7.3 | 7.2 | 21.8 | 7.2 | 0.0 |
| EL DORADO | 11.1 | 12.3 | 26.1 | 7.3 | 10.6 | 9.8 | 7.6 | 10.4 | 8.1 |
| FRESNO | 35.7 | 46.6 | 43.1 | 34.2 | 30.3 | 27.3 | 17.3 | 9.9 | 11.3 |
| GLENN | 16.1 | 23.8 | 54.6 | 19.3 | 11.5 | 19.0 | 18.8 | 14.9 | 3.7 |
| HUMBOLDT | 12.6 | 11.6 | 17.2 | 26.8 | 15.3 | 22.5 | 23.2 | 17.5 | 10.3 |
| IMPERIAL | 3.7 | 2.6 | 6.7 | 17.4 | 3.8 | 3.0 | 7.2 | 6.4 | 2.1 |
| INYO | 27.4 | 98.4 | 147.5 | 92.6 | 32.5 | 10.8 | 0.0 | 10.9 | 0.0 |
| KERN | 15.2 | 18.2 | 26.4 | 19.7 | 12.1 | 10.6 | 15.0 | 12.4 | 12.9 |
| KINGS | 12.8 | 27.9 | 10.3 | 28.3 | 4.5 | 1.8 | 3.5 | 10.3 | 6.6 |
| LAKE | 35.6 | 40.5 | 39.6 | 48.2 | 22.0 | 27.3 | 52.7 | 3.6 | 3.6 |
| LASSEN | 7.2 | 10.8 | 17.8 | 7.0 | 17.5 | 7.0 | 16.3 | 37.8 | 14.9 |
| **LONG BEACH** | 24.9 | 20.3 | 28.2 | 20.2 | 20.3 | 14.6 | 19.4 | 16.6 | 14.1 |
| LOS ANGELES | 21.8 | 19.4 | 19.6 | 19.4 | 13.5 | 10.6 | 11.1 | 9.0 | 8.0 |
| MADERA | 3.4 | 6.5 | 16.6 | 5.0 | 11.6 | 10.4 | 7.4 | 6.3 | 2.6 |
| MARIN | 46.9 | 66.8 | 90.9 | 59.7 | 58.2 | 57.5 | 31.4 | 43.1 | 40.1 |
| MARIPOSA | 14.0 | 20.3 | 19.8 | 19.3 | 0.0 | 6.3 | 12.6 | 0.0 | 12.5 |
| MENDOCINO | 27.4 | 25.7 | 14.6 | 22.9 | 17.9 | 52.4 | 36.7 | 39.8 | 26.7 |
| MERCED | 62.2 | 55.6 | 59.0 | 43.8 | 52.1 | 20.7 | 32.8 | 18.0 | 16.7 |
| MODOC | 20.7 | 20.5 | 60.8 | 70.2 | 19.9 | 29.9 | 10.0 | 19.7 | 20.1 |
| MONO | 20.1 | 59.7 | 10.0 | 68.3 | 19.0 | 9.4 | 9.5 | 19.0 | 28.4 |
| MONTEREY | 22.8 | 14.7 | 9.5 | 10.8 | 8.2 | 11.3 | 8.3 | 6.8 | 10.0 |
| NAPA | 35.2 | 30.3 | 95.1 | 62.4 | 41.2 | 54.6 | 27.0 | 26.6 | 33.6 |
| NEVADA | 54.8 | 34.8 | 58.4 | 20.3 | 29.4 | 14.0 | 38.0 | 29.6 | 16.8 |
| ORANGE | 27.6 | 19.3 | 26.8 | 26.6 | 11.8 | 15.6 | 13.6 | 12.0 | 9.9 |
| **PASADENA** | 35.7 | 43.8 | 38.2 | 28.9 | 19.9 | 11.7 | 20.4 | 19.5 | 14.3 |
| PLACER | 22.6 | 28.6 | 25.0 | 23.2 | 14.9 | 20.0 | 27.6 | 24.5 | 21.9 |
| PLUMAS | 15.2 | 181.4 | 266.7 | 97.3 | 38.8 | 29.3 | 19.6 | 39.3 | 39.1 |
| RIVERSIDE | 14.2 | 13.2 | 13.2 | 15.0 | 7.4 | 9.0 | 7.8 | 7.4 | 6.3 |
| SACRAMENTO | 23.1 | 30.9 | 24.6 | 18.0 | 8.6 | 5.6 | 5.6 | 6.8 | 9.2 |
| SAN BENITO | 16.4 | 21.4 | 28.8 | 25.4 | 4.9 | 4.8 | 13.8 | 33.3 | 14.9 |
| SAN BERNARDINO | 12.5 | 11.0 | 13.3 | 14.5 | 13.4 | 8.1 | 7.7 | 8.4 | 6.0 |
| SAN DIEGO | 12.7 | 12.2 | 19.2 | 28.2 | 26.3 | 21.6 | 18.9 | 16.7 | 16.3 |
| SAN FRANCISCO | 45.9 | 39.5 | 35.8 | 46.6 | 53.8 | 54.5 | 53.3 | 49.7 | 46.0 |
| SAN JOAQUIN | 61.4 | 54.3 | 59.4 | 38.6 | 48.5 | 37.5 | 33.7 | 21.2 | 18.1 |
| SAN LUIS OBISPO | 45.1 | 21.0 | 21.3 | 42.6 | 20.9 | 15.8 | 22.2 | 24.9 | 21.6 |
| SAN MATEO | 30.6 | 26.1 | 28.8 | 25.6 | 20.9 | 21.3 | 19.2 | 19.0 | 14.4 |
| SANTA BARBARA | 44.1 | 38.7 | 63.8 | 37.9 | 52.0 | 36.5 | 62.4 | 45.3 | 45.4 |
| SANTA CLARA | 43.5 | 36.0 | 36.2 | 39.5 | 35.0 | 32.0 | 27.9 | 22.3 | 18.2 |
| SANTA CRUZ | 21.8 | 16.0 | 47.1 | 12.3 | 16.4 | 18.8 | 14.0 | 14.3 | 13.7 |
| SHASTA | 12.9 | 13.9 | 15.5 | 17.1 | 19.5 | 8.7 | 2.5 | 5.5 | 4.9 |
| SIERRA | 0.0 | 0.0 | 121.2 | 120.5 | 29.9 | 59.3 | 29.6 | 0.0 | 59.9 |
| SISKIYOU | 25.3 | 34.3 | 34.2 | 18.1 | 31.4 | 6.7 | 6.8 | 36.2 | 9.0 |
| SOLANO | 21.5 | 12.0 | 16.2 | 18.4 | 16.8 | 17.8 | 14.0 | 12.3 | 17.0 |
| SONOMA | 31.4 | 27.1 | 39.2 | 33.4 | 26.2 | 29.8 | 31.0 | 16.3 | 15.3 |
| STANISLAUS | 38.9 | 35.1 | 30.9 | 29.2 | 22.6 | 22.1 | 16.3 | 11.9 | 6.5 |
| SUTTER | 43.5 | 28.7 | 32.3 | 27.1 | 36.3 | 37.0 | 28.3 | 18.6 | 14.4 |
| TEHAMA | 10.1 | 17.8 | 13.5 | 11.4 | 20.7 | 13.0 | 16.6 | 11.0 | 7.3 |
| TRINITY | 45.9 | 61.3 | 175.6 | 53.0 | 52.4 | 67.2 | 22.4 | 15.0 | 7.6 |
| TULARE | 12.5 | 12.8 | 31.4 | 19.7 | 19.7 | 25.7 | 16.8 | 9.6 | 12.2 |
| TUOLUMNE | 37.1 | 14.2 | 4.0 | 5.9 | 3.9 | 3.9 | 9.7 | 1.9 | 11.4 |
| VENTURA | 27.5 | 24.1 | 18.4 | 14.1 | 11.0 | 5.9 | 8.7 | 6.0 | 4.9 |
| YOLO | 20.5 | 32.8 | 30.3 | 29.3 | 16.9 | 22.1 | 33.0 | 21.5 | 16.1 |
| YUBA | 27.5 | 23.5 | 26.4 | 27.7 | 51.8 | 25.8 | 21.2 | 21.4 | 11.5 |

Table E-13a Reported Incidence of Hepatistis A in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 130 | 135 | 115 | 91 | 96 | 97 | 137 | 157 | 92 |
| ALPINE | | | | 1 | | | | | |
| AMADOR | 2 | | 2 | 5 | 1 | | 3 | 6 | |
| BERKELEY | 14 | 21 | 14 | 13 | 16 | 15 | 38 | 25 | 21 |
| BUTTE | 44 | 25 | 37 | 105 | 251 | 53 | 72 | 99 | 16 |
| CALAVERAS | 4 | 2 | 3 | 6 | 2 | 7 | 11 | | |
| COLUSA | 5 | 2 | 4 | | 13 | 3 | 6 | 4 | 1 |
| CONTRA COSTA | 114 | 75 | 67 | 90 | 78 | 78 | 105 | 81 | 58 |
| DEL NORTE | 2 | 48 | 5 | 46 | 46 | 52 | 4 | 5 | 4 |
| EL DORADO | 48 | 6 | 6 | 12 | 11 | 11 | 30 | 9 | 2 |
| FRESNO | 149 | 203 | 160 | 153 | 157 | 91 | 129 | 122 | 64 |
| GLENN | 13 | 3 | 2 | 1 | 29 | 2 | 13 | 6 | |
| HUMBOLDT | 59 | 22 | 13 | 59 | 401 | 219 | 68 | 22 | 1 |
| IMPERIAL | 26 | 30 | 49 | 22 | 45 | 46 | 60 | 33 | 23 |
| INYO | 1 | 5 | 1 | 6 | 26 | 10 | 1 | | |
| KERN | 168 | 121 | 310 | 346 | 491 | 258 | 171 | 111 | 290 |
| KINGS | 39 | 38 | 64 | 13 | 5 | 13 | 12 | 22 | 14 |
| LAKE | 69 | 51 | 19 | 14 | 6 | 23 | 10 | 9 | 1 |
| LASSEN | 2 | | | 8 | 12 | 2 | 10 | 9 | 3 |
| LONG BEACH | 127 | 81 | 70 | 93 | 124 | 207 | 198 | 168 | 73 |
| LOS ANGELES | 1395 | 1182 | 1411 | 1094 | 1120 | 1120 | 1163 | 1753 | 892 |
| MADERA | 21 | 25 | 20 | 11 | 41 | 20 | 18 | 17 | 33 |
| MARIN | 15 | 13 | 13 | | 12 | 34 | 40 | 32 | 13 |
| MARIPOSA | 2 | 1 | | 5 | 5 | | 1 | 1 | 6 |
| MENDOCINO | 23 | 35 | 8 | 30 | 15 | 35 | 14 | 7 | 9 |
| MERCED | 32 | 49 | 43 | 39 | 44 | 35 | 18 | 24 | 119 |
| MODOC | 1 | 3 | | 8 | 1 | 5 | 5 | 1 | |
| MONO | 1 | 1 | 2 | 4 | 3 | 3 | | 4 | 2 |
| MONTEREY | 66 | 66 | 41 | 34 | 56 | 60 | 42 | 64 | 53 |
| NAPA | 21 | 9 | 8 | 10 | 21 | 16 | 13 | 12 | 5 |
| NEVADA | 20 | 3 | 1 | 9 | 8 | 8 | 6 | 8 | 9 |
| ORANGE | 355 | 291 | 256 | 375 | 177 | 405 | 319 | 348 | 228 |
| PASADENA | 35 | 25 | 19 | 38 | 41 | 20 | 23 | 23 | 15 |
| PLACER | 79 | 20 | 47 | 15 | 22 | 16 | 48 | 35 | 17 |
| PLUMAS | 13 | | 2 | 1 | 6 | 6 | 2 | 2 | |
| RIVERSIDE | 367 | 193 | 182 | 149 | 312 | 339 | 381 | 340 | 168 |
| SACRAMENTO | 285 | 137 | 144 | 309 | 122 | 215 | 678 | 428 | 197 |
| SAN BENITO | 2 | 3 | 5 | 7 | 4 | 6 | 7 | 7 | 12 |
| SAN BERNARDINO | 480 | 230 | 162 | 209 | 361 | 499 | 565 | 333 | 247 |
| SAN DIEGO | 773 | 622 | 337 | 490 | 668 | 479 | 642 | 534 | 446 |
| SAN FRANCISCO | 259 | 284 | 381 | 220 | 293 | 450 | 581 | 599 | 287 |
| SAN JOAQUIN | 83 | 50 | 86 | 297 | 162 | 198 | 76 | 133 | 61 |
| SAN LUIS OBISPO | 32 | 18 | 13 | 8 | 21 | 19 | 19 | 25 | 9 |
| SAN MATEO | 66 | 60 | 48 | 45 | 49 | 66 | 106 | 78 | 67 |
| SANTA BARBARA | 60 | 64 | 44 | 67 | 84 | 84 | 38 | 71 | 54 |
| SANTA CLARA | 222 | 153 | 176 | 157 | 154 | 167 | 121 | 185 | 158 |
| SANTA CRUZ | 58 | 30 | 24 | 27 | 39 | 45 | 39 | 73 | 29 |
| SHASTA | 13 | 20 | 18 | 8 | 109 | 563 | 121 | 16 | 11 |
| SIERRA | | | | 4 | | 8 | | | |
| SISKIYOU | 7 | 4 | 3 | 3 | 66 | 52 | 6 | 4 | 1 |
| SOLANO | 50 | 19 | 17 | 25 | 120 | 45 | 86 | 93 | 103 |
| SONOMA | 81 | 98 | 102 | 87 | 81 | 107 | 56 | 39 | 31 |
| STANISLAUS | 80 | 109 | 240 | 465 | 154 | 119 | 75 | 52 | 36 |
| SUTTER | 23 | 11 | 6 | 38 | 91 | 43 | 9 | 8 | 16 |
| TEHAMA | 3 | 1 | 4 | 4 | 51 | 37 | 30 | 2 | 4 |
| TRINITY | 1 | | 8 | | 8 | 14 | 3 | | |
| TULARE | 125 | 208 | 120 | 99 | 75 | 72 | 90 | 55 | 56 |
| TUOLUMNE | 5 | 5 | 2 | 8 | 11 | 2 | 5 | 2 | 1 |
| VENTURA | 99 | 72 | 40 | 56 | 45 | 68 | 78 | 94 | 101 |
| YOLO | 34 | 11 | 17 | 20 | 37 | 26 | 27 | 22 | 34 |
| YUBA | 34 | 23 | 9 | 92 | 142 | 80 | 24 | 10 | 4 |
| Grand Total | 6414 | 5016 | 5000 | 5651 | 6641 | 6773 | 6653 | 6422 | 4197 |

Table E-13b Reported Incidence of Hepatistis A in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 11.1 | 11.3 | 9.5 | 7.4 | 7.8 | 7.8 | 10.9 | 12.3 | 7.0 |
| ALPINE | 0.0 | 0.0 | 0.0 | 88.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AMADOR | 6.7 | 0.0 | 6.4 | 15.6 | 3.1 | 0.0 | 9.2 | 18.1 | 0.0 |
| **BERKELEY** | 13.6 | 20.3 | 13.4 | 12.5 | 15.3 | 14.4 | 36.3 | 23.5 | 19.4 |
| BUTTE | 24.2 | 13.5 | 19.7 | 55.2 | 130.4 | 27.2 | 36.7 | 50.1 | 8.0 |
| CALAVERAS | 12.5 | 6.0 | 8.7 | 17.0 | 5.5 | 19.1 | 29.8 | 0.0 | 0.0 |
| COLUSA | 30.7 | 12.0 | 23.7 | 0.0 | 74.3 | 16.9 | 33.2 | 21.7 | 5.4 |
| CONTRA COSTA | 14.2 | 9.2 | 8.1 | 10.7 | 9.1 | 9.0 | 12.0 | 9.1 | 6.4 |
| DEL NORTE | 8.5 | 190.5 | 18.9 | 170.4 | 167.6 | 188.4 | 14.5 | 17.9 | 14.2 |
| EL DORADO | 38.1 | 4.6 | 4.5 | 8.7 | 7.8 | 7.7 | 20.8 | 6.3 | 1.3 |
| FRESNO | 22.3 | 29.6 | 22.7 | 21.2 | 21.4 | 12.2 | 16.9 | 15.8 | 8.2 |
| GLENN | 52.4 | 11.9 | 7.8 | 3.9 | 111.1 | 7.6 | 48.8 | 22.4 | 0.0 |
| HUMBOLDT | 49.5 | 18.3 | 10.7 | 47.9 | 323.1 | 176.3 | 54.5 | 17.5 | 0.8 |
| IMPERIAL | 23.8 | 26.4 | 41.1 | 17.4 | 34.0 | 33.9 | 43.1 | 23.4 | 16.1 |
| INYO | 5.5 | 27.3 | 5.5 | 32.7 | 140.9 | 54.2 | 5.4 | 0.0 | 0.0 |
| KERN | 30.8 | 21.6 | 53.5 | 58.3 | 81.3 | 42.1 | 27.6 | 17.6 | 45.5 |
| KINGS | 38.4 | 36.5 | 59.9 | 11.9 | 4.5 | 11.4 | 10.4 | 18.9 | 11.6 |
| LAKE | 136.3 | 98.5 | 35.8 | 26.0 | 11.0 | 41.9 | 18.2 | 16.4 | 1.8 |
| LASSEN | 7.2 | 0.0 | 0.0 | 28.1 | 42.0 | 7.0 | 32.6 | 26.2 | 8.9 |
| **LONG BEACH** | 29.6 | 18.4 | 15.8 | 21.1 | 28.3 | 47.4 | 45.2 | 38.1 | 16.4 |
| LOS ANGELES | 16.8 | 14.0 | 16.6 | 12.7 | 12.9 | 12.8 | 13.2 | 19.7 | 9.9 |
| MADERA | 23.8 | 27.2 | 20.8 | 11.0 | 39.5 | 18.9 | 16.6 | 15.2 | 28.9 |
| MARIN | 6.5 | 5.6 | 5.6 | 0.0 | 5.1 | 14.3 | 16.7 | 13.3 | 5.3 |
| MARIPOSA | 14.0 | 6.8 | 0.0 | 32.2 | 31.6 | 0.0 | 6.3 | 6.3 | 37.5 |
| MENDOCINO | 28.6 | 42.9 | 9.7 | 36.1 | 17.9 | 41.7 | 16.6 | 8.2 | 10.5 |
| MERCED | 17.9 | 26.7 | 22.9 | 20.3 | 22.5 | 17.7 | 9.1 | 12.0 | 58.6 |
| MODOC | 10.3 | 30.7 | 0.0 | 80.2 | 10.0 | 49.8 | 49.8 | 9.9 | 0.0 |
| MONO | 10.0 | 10.0 | 19.9 | 39.0 | 28.4 | 28.3 | 0.0 | 38.1 | 19.0 |
| MONTEREY | 18.6 | 18.3 | 11.2 | 9.2 | 15.3 | 16.6 | 11.6 | 17.3 | 13.9 |
| NAPA | 19.0 | 8.0 | 7.0 | 8.7 | 18.0 | 13.7 | 11.0 | 10.0 | 4.1 |
| NEVADA | 25.5 | 3.7 | 1.2 | 10.8 | 9.4 | 9.3 | 6.9 | 9.1 | 10.1 |
| ORANGE | 14.7 | 11.9 | 10.3 | 14.8 | 6.9 | 15.6 | 12.1 | 13.0 | 8.3 |
| **PASADENA** | 26.6 | 18.9 | 14.2 | 28.1 | 30.3 | 14.7 | 16.8 | 16.6 | 10.7 |
| PLACER | 45.7 | 11.2 | 25.5 | 7.9 | 11.3 | 8.0 | 23.3 | 16.5 | 7.7 |
| PLUMAS | 65.9 | 0.0 | 9.9 | 4.9 | 29.1 | 29.3 | 9.8 | 9.8 | 0.0 |
| RIVERSIDE | 31.4 | 15.8 | 14.3 | 11.4 | 23.4 | 25.0 | 27.6 | 24.3 | 11.7 |
| SACRAMENTO | 27.4 | 12.9 | 13.3 | 28.1 | 11.0 | 19.3 | 60.3 | 37.6 | 17.0 |
| SAN BENITO | 5.5 | 8.0 | 13.1 | 17.8 | 9.9 | 14.4 | 16.1 | 15.5 | 25.6 |
| SAN BERNARDINO | 33.8 | 15.7 | 10.7 | 13.6 | 23.2 | 31.7 | 35.6 | 20.7 | 15.1 |
| SAN DIEGO | 30.9 | 24.5 | 13.0 | 18.7 | 25.3 | 18.0 | 23.9 | 19.6 | 16.0 |
| SAN FRANCISCO | 35.8 | 38.8 | 51.8 | 29.6 | 39.0 | 59.8 | 76.5 | 77.5 | 36.6 |
| SAN JOAQUIN | 17.3 | 10.2 | 17.2 | 58.6 | 31.6 | 38.1 | 14.4 | 24.7 | 11.2 |
| SAN LUIS OBISPO | 14.7 | 8.2 | 5.9 | 3.6 | 9.3 | 8.4 | 8.3 | 10.7 | 3.8 |
| SAN MATEO | 10.2 | 9.1 | 7.2 | 6.7 | 7.2 | 9.6 | 15.3 | 11.1 | 9.4 |
| SANTA BARBARA | 16.2 | 17.1 | 11.6 | 17.5 | 21.8 | 21.6 | 9.7 | 17.9 | 13.4 |
| SANTA CLARA | 14.8 | 10.1 | 11.5 | 10.1 | 9.7 | 10.5 | 7.5 | 11.2 | 9.4 |
| SANTA CRUZ | 25.2 | 13.0 | 10.3 | 11.5 | 16.4 | 18.8 | 16.1 | 29.7 | 11.6 |
| SHASTA | 8.8 | 13.2 | 11.6 | 5.1 | 68.5 | 351.2 | 75.0 | 9.8 | 6.7 |
| SIERRA | 0.0 | 0.0 | 0.0 | 120.5 | 0.0 | 237.4 | 0.0 | 0.0 | 0.0 |
| SISKIYOU | 16.1 | 9.2 | 6.8 | 6.8 | 148.1 | 116.5 | 13.5 | 9.1 | 2.3 |
| SOLANO | 14.7 | 5.4 | 4.7 | 6.8 | 32.5 | 12.2 | 23.1 | 24.8 | 27.0 |
| SONOMA | 20.9 | 24.9 | 25.4 | 21.3 | 19.6 | 25.7 | 13.3 | 9.1 | 7.1 |
| STANISLAUS | 21.6 | 28.5 | 61.2 | 116.1 | 37.8 | 28.9 | 18.0 | 12.3 | 8.4 |
| SUTTER | 35.7 | 16.6 | 8.8 | 54.2 | 126.9 | 58.9 | 12.1 | 10.6 | 20.9 |
| TEHAMA | 6.0 | 2.0 | 7.7 | 7.6 | 95.9 | 68.8 | 55.2 | 3.7 | 7.3 |
| TRINITY | 7.7 | 0.0 | 61.1 | 0.0 | 59.9 | 104.5 | 22.4 | 0.0 | 0.0 |
| TULARE | 40.1 | 65.1 | 36.6 | 29.6 | 22.0 | 20.8 | 25.6 | 15.5 | 15.6 |
| TUOLUMNE | 10.3 | 10.1 | 4.0 | 15.7 | 21.2 | 3.9 | 9.7 | 3.9 | 1.9 |
| VENTURA | 14.8 | 10.7 | 5.9 | 8.1 | 6.4 | 9.6 | 10.9 | 13.0 | 13.8 |
| YOLO | 24.1 | 7.7 | 11.7 | 13.6 | 25.1 | 17.4 | 17.8 | 14.3 | 21.9 |
| YUBA | 58.4 | 38.7 | 14.9 | 149.8 | 229.8 | 128.8 | 39.1 | 16.4 | 6.6 |

Table E-14a Reported Incidence of Viral Meningitis in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 30 | 23 | 37 | 27 | 6 | 15 | 12 | 90 | 29 |
| BERKELEY | 5 | 1 | 6 | 5 | 2 | 4 | 2 | 12 | 5 |
| BUTTE | 9 | 10 | 5 | 11 | 2 | 3 | 6 | 15 | 8 |
| CALAVERAS | | 1 | | | | | | 8 | 1 |
| COLUSA | | | 1 | | | | | | |
| CONTRA COSTA | 19 | 20 | 37 | 26 | 21 | 28 | 11 | 59 | 10 |
| DEL NORTE | | 1 | 1 | | | | | | 2 |
| EL DORADO | 1 | 1 | 3 | 2 | 5 | 5 | 10 | 15 | 10 |
| FRESNO | 47 | 57 | 103 | 137 | 89 | 40 | 68 | 89 | 128 |
| GLENN | 3 | 2 | 1 | 5 | 2 | | 1 | 3 | |
| HUMBOLDT | 7 | 1 | | 3 | 2 | 5 | 4 | 16 | 7 |
| IMPERIAL | 7 | 10 | 51 | 33 | 22 | 8 | 4 | 17 | 13 |
| INYO | | | 3 | | | | | | |
| KERN | 78 | 72 | 78 | 115 | 79 | 54 | 46 | 40 | 53 |
| KINGS | 5 | 1 | 5 | 3 | | | 1 | 5 | 3 |
| LAKE | 2 | 1 | 2 | 2 | 2 | | 2 | 1 | 4 |
| LASSEN | | | 1 | | 1 | | 2 | 1 | 2 |
| LONG BEACH | 31 | 37 | 86 | 69 | 18 | 22 | 35 | 30 | 87 |
| LOS ANGELES | 328 | 192 | 895 | 535 | 263 | 166 | 191 | 221 | 446 |
| MADERA | 1 | 1 | 11 | 4 | 6 | 4 | 3 | 6 | 10 |
| MARIN | 10 | 12 | 15 | 1 | 9 | 6 | 9 | 25 | 9 |
| MARIPOSA | | | 1 | 3 | | | | 1 | 2 |
| MENDOCINO | 1 | | 2 | 1 | | 1 | 4 | 13 | 11 |
| MERCED | 5 | 3 | 3 | 10 | 2 | 3 | | 4 | 8 |
| MODOC | 2 | | | 2 | | | | | |
| MONO | | | 2 | 1 | 2 | | | 2 | |
| MONTEREY | 25 | 17 | 27 | 12 | 6 | 9 | 6 | 14 | 11 |
| NAPA | 11 | 8 | 12 | 13 | 5 | 12 | 16 | 37 | 2 |
| NEVADA | 13 | 6 | 9 | 5 | 4 | 4 | 6 | 7 | 10 |
| ORANGE | 205 | 194 | 714 | 394 | 110 | 181 | 204 | 275 | 586 |
| PASADENA | 2 | 5 | 5 | 8 | 3 | 1 | 4 | 3 | 12 |
| PLACER | 6 | 4 | 14 | 12 | 9 | 12 | 8 | 53 | 20 |
| PLUMAS | | | | 2 | | | 1 | 2 | 1 |
| RIVERSIDE | 67 | 72 | 269 | 126 | 63 | 62 | 49 | 83 | 224 |
| SACRAMENTO | 40 | 47 | 42 | 55 | 72 | 46 | 39 | 160 | 101 |
| SAN BENITO | 1 | | 1 | | | 2 | 1 | 2 | 2 |
| SAN BERNARDINO | 88 | 63 | 131 | 156 | 62 | 48 | 54 | 62 | 171 |
| SAN DIEGO | 170 | 170 | 498 | 228 | 210 | 199 | 97 | 220 | 514 |
| SAN FRANCISCO | 12 | 7 | 23 | 12 | 1 | 4 | 5 | 4 | 7 |
| SAN JOAQUIN | 4 | 6 | 27 | 9 | 10 | 15 | 2 | 33 | 13 |
| SAN LUIS OBISPO | 5 | 3 | 21 | 23 | 17 | 20 | 13 | 35 | 50 |
| SAN MATEO | 10 | 17 | 12 | 13 | 10 | 9 | 3 | 7 | 9 |
| SANTA BARBARA | 7 | 4 | 47 | 24 | 12 | 13 | 13 | 25 | 42 |
| SANTA CLARA | 66 | 66 | 87 | 85 | 45 | 47 | 60 | 160 | 78 |
| SANTA CRUZ | 21 | 18 | 48 | 15 | 2 | 6 | 23 | 19 | 16 |
| SHASTA | 3 | 4 | 3 | 6 | 16 | 21 | 7 | 68 | 18 |
| SIERRA | | | | | | 1 | | | |
| SISKIYOU | 1 | | 1 | | | | | 1 | |
| SOLANO | 35 | 16 | 48 | 32 | 17 | 19 | 15 | 90 | 31 |
| SONOMA | 17 | 12 | 15 | 18 | 8 | 7 | 13 | 29 | 19 |
| STANISLAUS | 32 | 29 | 61 | 47 | 67 | 53 | 44 | 115 | 74 |
| SUTTER | 3 | 4 | 4 | 7 | 5 | 3 | 4 | 19 | 9 |
| TEHAMA | 3 | 1 | 2 | 5 | 1 | 1 | | 5 | 2 |
| TRINITY | | | | | | 1 | | 2 | |
| TULARE | 36 | 53 | 57 | 52 | 54 | 33 | 17 | 45 | 34 |
| TUOLUMNE | | 5 | 3 | 4 | 1 | | | | 2 |
| VENTURA | 44 | 22 | 104 | 47 | 24 | 36 | 29 | 38 | 117 |
| YOLO | 2 | 1 | 8 | 4 | 1 | 2 | | 5 | 7 |
| YUBA | 4 | 1 | 6 | 2 | 2 | 3 | 2 | 16 | 8 |
| Grand Total | 1525 | 1301 | 3648 | 2411 | 1370 | 1234 | 1146 | 2307 | 3038 |

Table E-14b Reported Incidence of Viral Meningitis in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| ALAMEDA | 2.6 | 1.9 | 3.1 | 2.2 | 0.5 | 1.2 | 1.0 | 7.1 | 2.2 |
| **BERKELEY** | 4.9 | 1.0 | 5.8 | 4.8 | 1.9 | 3.8 | 1.9 | 11.3 | 4.6 |
| BUTTE | 4.9 | 5.4 | 2.7 | 5.8 | 1.0 | 1.5 | 3.1 | 7.6 | 4.0 |
| CALAVERAS | 0.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 21.6 | 2.6 |
| COLUSA | 0.0 | 0.0 | 5.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CONTRA COSTA | 2.4 | 2.5 | 4.5 | 3.1 | 2.5 | 3.2 | 1.3 | 6.7 | 1.1 |
| DEL NORTE | 0.0 | 4.0 | 3.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.1 |
| EL DORADO | 0.8 | 0.8 | 2.2 | 1.5 | 3.5 | 3.5 | 6.9 | 10.4 | 6.7 |
| FRESNO | 7.0 | 8.3 | 14.6 | 19.0 | 12.1 | 5.4 | 8.9 | 11.5 | 16.4 |
| GLENN | 12.1 | 7.9 | 3.9 | 19.3 | 7.7 | 0.0 | 3.8 | 11.2 | 0.0 |
| HUMBOLDT | 5.9 | 0.8 | 0.0 | 2.4 | 1.6 | 4.0 | 3.2 | 12.7 | 5.6 |
| IMPERIAL | 6.4 | 8.8 | 42.8 | 26.1 | 16.6 | 5.9 | 2.9 | 12.1 | 9.1 |
| INYO | 0.0 | 0.0 | 16.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| KERN | 14.3 | 12.8 | 13.5 | 19.4 | 13.1 | 8.8 | 7.4 | 6.4 | 8.3 |
| KINGS | 4.9 | 1.0 | 4.7 | 2.7 | 0.0 | 0.0 | 0.9 | 4.3 | 2.5 |
| LAKE | 4.0 | 1.9 | 3.8 | 3.7 | 3.7 | 0.0 | 3.6 | 1.8 | 7.3 |
| LASSEN | 0.0 | 0.0 | 3.6 | 0.0 | 3.5 | 0.0 | 6.5 | 2.9 | 5.9 |
| **LONG BEACH** | 7.2 | 8.4 | 19.4 | 15.7 | 4.1 | 5.0 | 8.0 | 6.8 | 19.5 |
| LOS ANGELES | 4.0 | 2.3 | 10.5 | 6.2 | 3.0 | 1.9 | 2.2 | 2.5 | 5.0 |
| MADERA | 1.1 | 1.1 | 11.4 | 4.0 | 5.8 | 3.8 | 2.8 | 5.4 | 8.8 |
| MARIN | 4.3 | 5.2 | 6.4 | 0.4 | 3.8 | 2.5 | 3.8 | 10.4 | 3.7 |
| MARIPOSA | 0.0 | 0.0 | 6.6 | 19.3 | 0.0 | 0.0 | 0.0 | 6.3 | 12.5 |
| MENDOCINO | 1.2 | 0.0 | 2.4 | 1.2 | 0.0 | 1.2 | 4.7 | 15.2 | 12.8 |
| MERCED | 2.8 | 1.6 | 1.6 | 5.2 | 1.0 | 1.5 | 0.0 | 2.0 | 3.9 |
| MODOC | 20.7 | 0.0 | 0.0 | 20.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MONO | 0.0 | 0.0 | 19.9 | 9.8 | 19.0 | 0.0 | 0.0 | 19.0 | 0.0 |
| MONTEREY | 7.0 | 4.7 | 7.4 | 3.2 | 1.6 | 2.5 | 1.7 | 3.8 | 2.9 |
| NAPA | 9.9 | 7.1 | 10.6 | 11.3 | 4.3 | 10.2 | 13.5 | 30.8 | 1.6 |
| NEVADA | 16.6 | 7.5 | 10.9 | 6.0 | 4.7 | 4.7 | 6.9 | 8.0 | 11.2 |
| ORANGE | 8.5 | 7.9 | 28.7 | 15.6 | 4.3 | 7.0 | 7.7 | 10.3 | 21.4 |
| **PASADENA** | 1.5 | 3.8 | 3.7 | 5.9 | 2.2 | 0.7 | 2.9 | 2.2 | 8.6 |
| PLACER | 3.5 | 2.2 | 7.6 | 6.3 | 4.6 | 6.0 | 3.9 | 25.0 | 9.1 |
| PLUMAS | 0.0 | 0.0 | 0.0 | 9.7 | 0.0 | 0.0 | 4.9 | 9.8 | 4.9 |
| RIVERSIDE | 5.7 | 5.9 | 21.2 | 9.7 | 4.7 | 4.6 | 3.5 | 5.9 | 15.5 |
| SACRAMENTO | 3.8 | 4.4 | 3.9 | 5.0 | 6.5 | 4.1 | 3.5 | 14.0 | 8.7 |
| SAN BENITO | 2.7 | 0.0 | 2.6 | 0.0 | 0.0 | 4.8 | 2.3 | 4.4 | 4.3 |
| SAN BERNARDINO | 6.2 | 4.3 | 8.7 | 10.1 | 4.0 | 3.1 | 3.4 | 3.9 | 10.5 |
| SAN DIEGO | 6.8 | 6.7 | 19.3 | 8.7 | 8.0 | 7.5 | 3.6 | 8.1 | 18.4 |
| SAN FRANCISCO | 1.7 | 1.0 | 3.1 | 1.6 | 0.1 | 0.5 | 0.7 | 0.5 | 0.9 |
| SAN JOAQUIN | 0.8 | 1.2 | 5.4 | 1.8 | 1.9 | 2.9 | 0.4 | 6.1 | 2.4 |
| SAN LUIS OBISPO | 2.3 | 1.4 | 9.5 | 10.3 | 7.5 | 8.8 | 5.7 | 15.0 | 21.2 |
| SAN MATEO | 1.5 | 2.6 | 1.8 | 1.9 | 1.5 | 1.3 | 0.4 | 1.0 | 1.3 |
| SANTA BARBARA | 1.9 | 1.1 | 12.4 | 6.3 | 3.1 | 3.3 | 3.3 | 6.3 | 10.4 |
| SANTA CLARA | 4.4 | 4.4 | 5.7 | 5.4 | 2.8 | 2.9 | 3.7 | 9.7 | 4.6 |
| SANTA CRUZ | 9.1 | 7.8 | 20.5 | 6.4 | 0.8 | 2.5 | 9.5 | 7.7 | 6.4 |
| SHASTA | 2.0 | 2.6 | 1.9 | 3.8 | 10.1 | 13.1 | 4.3 | 41.8 | 11.0 |
| SIERRA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.7 | 0.0 | 0.0 | 0.0 |
| SISKIYOU | 2.3 | 0.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 0.0 |
| SOLANO | 10.3 | 4.6 | 13.4 | 8.8 | 4.6 | 5.1 | 4.0 | 24.0 | 8.1 |
| SONOMA | 4.4 | 3.0 | 3.7 | 4.4 | 1.9 | 1.7 | 3.1 | 6.8 | 4.4 |
| STANISLAUS | 8.6 | 7.6 | 15.6 | 11.7 | 16.5 | 12.9 | 10.6 | 27.3 | 17.3 |
| SUTTER | 4.7 | 6.0 | 5.9 | 10.0 | 7.0 | 4.1 | 5.4 | 25.2 | 11.8 |
| TEHAMA | 6.0 | 2.0 | 3.9 | 9.5 | 1.9 | 1.9 | 0.0 | 9.2 | 3.6 |
| TRINITY | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.5 | 0.0 | 15.0 | 0.0 |
| TULARE | 11.5 | 16.6 | 17.4 | 15.5 | 15.8 | 9.5 | 4.8 | 12.6 | 9.4 |
| TUOLUMNE | 0.0 | 10.1 | 6.0 | 7.8 | 1.9 | 0.0 | 0.0 | 0.0 | 3.8 |
| VENTURA | 6.6 | 3.3 | 15.2 | 6.8 | 3.4 | 5.1 | 4.1 | 5.3 | 16.0 |
| YOLO | 1.4 | 0.7 | 5.5 | 2.7 | 0.7 | 1.3 | 0.0 | 3.3 | 4.5 |
| YUBA | 6.9 | 1.7 | 9.9 | 3.3 | 3.2 | 4.8 | 3.3 | 26.3 | 13.2 |

Table E-15a  Reported Incidence of Toxoplasmosis in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| BERKELEY | | | | | | 1 | | | 1 |
| BUTTE | | | | | | | | | 1 |
| CONTRA COSTA | | | | | | | | | 1 |
| HUMBOLDT | | | | | | | 1 | | |
| LAKE | | | | | | | 1 | | |
| LONG BEACH | 1 | | | 2 | | 1 | 1 | 1 | 1 |
| LOS ANGELES | 30 | 13 | 7 | 49 | 12 | 39 | 27 | 22 | 14 |
| MENDOCINO | | | | | | | | | 1 |
| MERCED | | | | | | | | | 1 |
| MONTEREY | 1 | | | | | | | 1 | 1 |
| ORANGE | 1 | | | | | | | | |
| PASADENA | | | 1 | | | | 1 | 1 | |
| RIVERSIDE | 1 | 4 | 1 | | 2 | | | | |
| SACRAMENTO | 5 | | | | | | | | |
| SAN BERNARDINO | 2 | | | | 1 | | | | 2 |
| SAN DIEGO | | 2 | | | 2 | 1 | 1 | | |
| SAN FRANCISCO | 148 | 1 | | | | | | | |
| SAN LUIS OBISPO | | | | | | | | | 1 |
| SAN MATEO | 3 | 1 | | | | | | | |
| SHASTA | | | | | | | | | 2 |
| SOLANO | | | | | | | | 1 | 1 |
| SONOMA | | | | 1 | | | | | |
| Grand Total | 192 | 21 | 9 | 52 | 17 | 42 | 32 | 27 | 27 |

Table E-15b  Reported Incidence of Toxoplasmosis in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| **BERKELEY** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.9 |
| BUTTE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| CONTRA COSTA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| HUMBOLDT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 |
| LAKE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 |
| **LONG BEACH** | 0.2 | 0.0 | 0.0 | 0.5 | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 |
| LOS ANGELES | 0.4 | 0.2 | 0.1 | 0.6 | 0.1 | 0.4 | 0.3 | 0.2 | 0.2 |
| MENDOCINO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 |
| MERCED | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |
| MONTEREY | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 |
| ORANGE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **PASADENA** | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.7 | 0.7 | 0.0 |
| RIVERSIDE | 0.1 | 0.3 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| SACRAMENTO | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SAN BERNARDINO | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| SAN DIEGO | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| SAN FRANCISCO | 20.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SAN LUIS OBISPO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 |
| SAN MATEO | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SHASTA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 |
| SOLANO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.3 |
| SONOMA | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table E-16a  Reported Incidence of Taenia Tapeworm Infection in California (1990-1998)

| | Reported Cases by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| BUTTE | | | | | | 1 | | | |
| KERN | | | | | | | | 1 | |
| LOS ANGELES | 7 | 8 | 8 | 2 | 7 | 6 | | 1 | 1 |
| MONTEREY | 1 | | | | | | | | |
| NAPA | | | 1 | | | | | | |
| ORANGE | 2 | 9 | 4 | | | 3 | 1 | 1 | |
| PASADENA | | | | | | 1 | | | |
| RIVERSIDE | | | 1 | | | | | | |
| SAN BERNARDINO | 1 | | | | | | | 1 | |
| SAN DIEGO | | 1 | | | | | | | |
| SAN FRANCISCO | | 1 | 2 | | | | | | |
| SANTA CLARA | 1 | 27 | 2 | 3 | 2 | | | | |
| SONOMA | 2 | | | | | | | | |
| STANISLAUS | 2 | | | | | | | | |
| TULARE | | | | | | | | | 1 |
| Grand Total | 16 | 46 | 18 | 5 | 9 | 11 | 1 | 4 | 2 |

Table E-16b  Reported Incidence of Taenia Tapeworm Infection in California (1990-1998)

| | Disease Incidence/100,000 by Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Local Health Department | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| BUTTE | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.514 | 0.000 | 0.000 | 0.000 |
| KERN | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.159 | 0.000 |
| LOS ANGELES | 0.084 | 0.095 | 0.094 | 0.023 | 0.080 | 0.069 | 0.000 | 0.011 | 0.011 |
| MONTEREY | 0.281 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| NAPA | 0.000 | 0.000 | 0.880 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ORANGE | 0.083 | 0.368 | 0.161 | 0.000 | 0.000 | 0.116 | 0.038 | 0.037 | 0.000 |
| **PASADENA** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.733 | 0.000 | 0.000 | 0.000 |
| RIVERSIDE | 0.000 | 0.000 | 0.079 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SAN BERNARDINO | 0.071 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.062 | 0.000 |
| SAN DIEGO | 0.000 | 0.039 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SAN FRANCISCO | 0.000 | 0.137 | 0.272 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SANTA CLARA | 0.067 | 1.781 | 0.130 | 0.192 | 0.126 | 0.000 | 0.000 | 0.000 | 0.000 |
| SONOMA | 0.515 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| STANISLAUS | 0.540 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TULARE | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.278 |

# Appendix F. Information on Special-Status Species

Table F-1. California Special-Status Plant Species



| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| San Mateo thorn-mint *Acanthomintha duttonii* | E/E/1B | Central Coast, San Francisco Bay area: endemic to San Mateo County | Chaparral, valley and foothill grassland/serpentinite | Apr-Jun |
| San Diego thorn-mint *Acanthomintha ilicifolia* | T/E/1B | San Diego; Baja California | Chaparral, coastal scrub, valley and foothill grassland, vernal pools/clay | Apr-Jun |
| Munz's onion *Allium munzii* | E/T/1B | Riverside County | Chaparral, cismontane woodland, coastal scrub, pinyon and juniper woodland, valley and foothill grassland, mesic, clay | Mar-May |
| Rawhide Hill onion *Allium tuolumnense* | PT/--/1B | Central Sierra Nevada foothills: Rawhide Hill, Redhills, Tuolumne County | Cismontane woodland on serpentine soils | May |
| Sonoma alopecurus *Alopecurus aequalis* var. *sonomensis* | E/--/1B | Central coast, including portions of Marin and Sonoma Counties | Marshes and swamps (freshwater), riparian scrub | May-Jul |
| Large-flowered fiddleneck *Amsinckia grandiflora* | E/E/1B | San Joaquin Valley: Alameda, Contra Costa, and San Joaquin Counties; currently known from only two natural occurrences | Annual grassland, cismontane woodland, on open grassy slopes below 1,200 feet | Apr-May |
| Hoffmann's rock cress *Arabis hoffmannii* | E/--/1B | Anacapa Island*, Santa Cruz Island, Santa Rosa Island | Coastal bluff scrub, chaparral, coastal scrub / rocky, volcanic cliff ledges | Feb-Apr |
| Johnston's rock cress *Arabis johnstonii* | PT/--/1B | San Jacinto Mountains, Riverside County | Chaparral, Lower montane coniferous forest, often on eroded clay | Feb-Jun |
| McDonald's rock cress *Arabis macdonaldiana* | E/E/1B | Outer north Coast Range, including portions of Del Norte, Mendocino, Siskiyou, and Trinity Counties; Oregon | Lower montane coniferous forest, upper montane coniferous forest, serpentine | May-Jun |

* = extirpated from that area, (?) = uncertain whether occurs in that area.

| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Santa Rosa Island manzanita *Arctostaphylos confertiflora* | E/--/1B | Santa Rosa Island | Broadleafed upland forest, closed-cone coniferous forest, chaparral, sandstone | Feb-Apr |
| Vine Hill manzanita *Arctostaphylos densiflora* | SC/E/1B | South northern outer Coast Ranges: Vine Hill, Forestville, Sonoma County | Chaparral (acid marine sand) | Feb-Mar |
| Del Mar manzanita *Arctostaphylos glandulosa* ssp. *crassifolia* | E/--/1B | Southern south coast, San Diego County; Baja California | Chaparral (maritime, sandy mesas and bluffs) | Dec-Apr |
| Hearst's manzanita *Arctostaphylos hookeri* ssp. *hearstiorum* | SC/E/1B | Central coast: Arroyo de la Cruz, San Luis Obispo County | Chaparral (maritime), coastal prairie, coastal scrub, valley and foothill grassland, sandy | Feb-Apr |
| Presidio manzanita *Arctostaphylos hookeri* ssp. *ravenii* | E/E/1B | Northern central coast: San Francisco Presidio, San Francisco County | Chaparral, coastal prairie, coastal scrub, serpentine soils | Feb-Mar |
| San Bruno Mountain manzanita *Arctostaphylos imbricata* | SC/E/1B | Western San Francisco Bay: San Bruno Mountain, San Mateo County | Chaparral | Feb-May |
| Morro Bay manzanita *Arctostaphylos morroensis* | T/--/1B | Southern central coast: Morro Bay, San Luis Obispo County | Chaparral, cismontane woodland, coastal dunes (pre-flandrian), coastal scrub, sandy loam soils | Jan-Mar |
| Ione manzanita *Arctostaphylos myrtifolia* | PT/--/1B | Central Sierra Nevada foothills: Amador and Calaveras Counties | Chaparral, cismontane woodland, acidic Ione clay or sandy soils | Nov-Feb |
| Pallid manzanita *Arctostaphylos pallida* | T/E/1B | Eastern San Francisco Bay area:- Sobrante and Huckleberry ridges, Berkeley-Oakland Hills, Alameda and Contra Costa Counties | Chaparral, on dry stony ridges; cismontaine woodland; broadleaf forest; 660-1155 feet elevation; in shale | January-March |
| Marsh sandwort *Arenaria paludicola* | E/E/1B | Only known occurrence near Black Lake on Nipomo Mesa, San Luis Obispo County; historically more wide ranging | Marshes and swamps (freshwater) | May-Aug |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Big Bear Valley sandwort *Arenaria ursina* | PT/--/1B | Eastern San Bernardino Mountains: Bear Valley, San Bernardino County | Pebble plain (pavement); Pinyon and juniper woodland; mesic, rocky soils | May-Aug |
| Humboldt milk-vetch *Astragalus agnicidus* | SC/E/1B | Outer north Coast Ranges: Humboldt County | Broadleafed upland forest (disturbed openings) | Jun-Aug |
| Cushenbury milk-vetch *Astragalus albens* | E/--/1B | Northeast San Bernardino Mountains, Mojave Desert: Cushenbury Canyon, San Bernardino County | Joshua tree woodland, Mohavean Desert scrub, pinyon and juniper woodland, carbonate or granitic | Mar-May |
| Braunton's milk-vetch *Astragalus brauntonii* | E/--/1B | Simi Hills in eastern Ventura and western Los Angeles Counties: San Ynez Canyon, Los Angeles County; Coal and Gypsum Canyons, Orange County | Chaparral (on limestone outcrops), closed-cone coniferous forest, chaparral, coastal scrub, valley and foothill grassland, recent burns or disturbed areas | March-July |
| Clara Hunt's milk-vetch *Astragalus clarianus* | E/T/1B | Southern north Coast Ranges, including portions of Napa and Sonoma Counties | Chaparral (openings); cismontane woodland; valley and foothill grassland; serpentinite, volcanic, rocky, clay | Mar-Apr |
| Lane Mountain milk-vetch *Astragalus jaegerianus* | E/--/1B | Mojave Desert (near Barstow), San Bernardino County | Joshua tree woodland; Mohavean Desert scrub; granitic, sandy, or gravelly | Apr-Jun |
| Coachella Valley milk-vetch *Astragalus lentiginosus* var. *coachellae* | E/--/1B | Sonaran Desert: Coachella Valley, Riverside County | Sonoran Desert scrub (sandy) | Feb-May |
| Fish Slough milk-vetch *Astragalus lentiginosus* var. *piscinensis* | T/--/1B | East of Sierra Nevada, Inyo and Mono Counties | Playas (alkaline) | Jun-Jul |

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|---|---|---|---|---|
| Sodaville milk-vetch *Astragalus lentiginosus* var. *sesquimetralis* | --/E/1B | Northern Mojave Desert, northern Death Valley, eastern slope of Last Chance Mountains, Inyo County; Nevada | Meadows (alkaline) | Jun-Jul |
| Peirson's milk-vetch *Astragalus magdalenae* var. *peirsonii* | T/E/1B | Sonoran Desert, Imperial and San Diego*(?) Counties; Arizona; Baja California; Sonora, Mexico | Desert dunes | Dec-Apr |
| Coastal dunes milk-vetch *Astragalus tener* var. *titi* | PE/E/1B | Central coast/southern coast, including portions of Los Angeles*, Monterey, and San Diego*(?) Counties | Coastal bluff scrub (sandy), coastal dunes, coastal prairie on mesic/sandy depressions near the coast | Mar-May |
| Triple-ribbed milk-vetch *Astragalus tricarinatus* | E/--/1B | Riverside and San Bernardino Counties | Joshua tree woodland, Sonoran Desert scrub, sandy or gravelly | Feb-May |
| San Jacinto Valley crownscale *Atriplex coronata* var. *notatior* | E/--/1B | Eastern south coast: San Jacinto Valley, Riverside County | Playas, valley and foothill grassland (mesic), vernal pools, alkaline | Apr-Aug |
| Bakersfield smallscale *Atriplex tularensis* | SC/E/1B | Southern San Joaquin Valley: Kern Lake bed, Kern County (possibly extinct) | Valley sink scrub | Jun-Oct |
| Encinitas baccharis *Baccharis vanessae* | T/E/1B | Southern south coast, northwestern Peninsular Ranges: San Diego County | Chaparral (maritime, sandstone) | Aug-Nov |
| Nevin's barberry *Berberis nevinii* | E/E/1B | Los Angeles, San Bernardino, Riverside, and San Diego Counties | Chaparral, coastal sage scrub, on dry slopes and in sandy washes, at 900 to 1,600 feet | March-April |
| Island barberry *Berberis pinnata* ssp. *insularis* | E/E/1B | Anacapa Island, Santa Cruz Island, Santa Rosa Island* | Closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, rocky | Mar |
| Sonoma sunshine *Blennosperma bakeri* | E/E/1B | North Coast Ranges, northeastern San Francisco Bay: southern Sonoma County | Valley and foothill grassland (mesic), vernal pools | Mar-Apr |

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|---|---|---|---|---|
| Indian Valley brodiaea<br>*Brodiaea coronaria* ssp. *rosea* | SC/E/1B | Inner north Coast Ranges: Colusa, Glenn, Lake, and Tehama Counties | Chaparral; closed-cone coniferous forest; cismontane woodland; valley and foothill grassland; in meadows, streambanks, and other vernally moist areas; serpentinite | May-June |
| Thread-leaved brodiaea<br>*Brodiaea filifolia* | PT/E/1B | Southern south coast, western Peninsular Ranges: Los Angeles*, western Riverside, San Bernardino*, San Diego Counties | Coastal scrub, cismontaine woodlands, annual grasslands and margins of vernal pools, on gentle hillsides, valleys and floodplains, in clay-loam or alkaline silty-clay soils | Mar-Jun |
| Kaweah brodiaea<br>*Brodiaea insignis* | SC/E/1B | Southern Sierra Nevada foothills: Kaweah and Tule River drainages, Tulare County | Cismontane woodland, valley and foothill grassland, granitic or clay | Apr-Jun |
| Chinese Camp brodiaea<br>*Brodiaea pallida* | PE/E/1B | Central Sierra Nevada foothills, near Chinese Camp, Tuolumne County | Valley and foothill grassland, vernal swale, on serpentine clay | May-Jun |
| Tiburon mariposa lily<br>*Calochortus tiburonensis* | T/T/1B | Northwestern San Francisco Bay: Ring Mountain, Marin County | Valley and foothill grassland (serpentinite) | Mar-Jun |
| Mariposa pussypaws<br>*Calyptridium pulchellum* | PE/--/1B | Central Sierra Nevada: Fresno, Madera, and Mariposa Counties | Cismontane woodland (sandy) | Apr-May |
| Stebbin's morning-glory<br>*Calystegia stebbinsii* | E/E/1B | Northern Sierra Nevada foothills: Placer and El Dorado Counties | Serpentine or gabbro chaparral opening, woodland | May-June |
| San Benito evening-primrose<br>*Camissonia benitensis* | T/--/1B | Inner south Coast Ranges: lower Clear Creek drainage, Fresno and San Benito Counties | Chaparral, cismontane woodland, serpentinite alluvium, clay or gravelly | May-Jun |
| White sedge<br>*Carex albida* | E/E/1B | Southern outer north Coast Ranges: Sonoma County | Bogs and fens, marshes and swamps (freshwater) | May-Jul |

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|---|---|---|---|---|
| Tree-anemone *Carpenteria californica* | PT/T/1B | Central and southern Sierra Nevada foothills: Kings and San Joaquin Rivers, Fresno and Madera Counties | Chaparral, cismontane woodland, granitic | May-Jul |
| Tiburon Indian paintbrush *Castilleja affinis* ssp. *neglecta* | E/T/1B | Southern inner north Coast Ranges, northwestern San Francisco Bay: Marin, Napa and Santa Clara Counties | Serpentine grasslands | April-June |
| Succulent owl's-clover *Castilleja campestris* ssp. *succulenta* | T/E/1B | Southern Sierra Nevada foothills, eastern San Joaquin Valley: Fresno, Madera, Merced, Mariposa, San Joaquin, and Stanislaus Counties | Vernal pools (often acidic) | Apr-May |
| Ash-gray Indian paintbrush *Castilleja cinerea* | PT/--/1B | San Bernardino Mountains, San Bernardino County | Mohavean Desert scrub, meadows, pebble plain, pinyon and juniper woodland, upper montane coniferous forest (clay openings) | Jun-Jul |
| San Clemente Island Indian paintbrush *Castilleja grisea* | E/E/1B | San Clemente Island | Coastal bluff scrub, coastal scrub, rocky | Feb-Aug |
| Soft-leaved Indian paintbrush *Castilleja mollis* | E/--/1B | San Miguel Island(?)*, Santa Rosa Island | Coastal bluff scrub, coastal dunes | Apr-Aug |
| Pitkin Marsh Indian paintbrush *Castilleja uliginosa* | SC/E/1A | Sonoma* County | Marshes and swamps (freshwater) | Jun-Jul |
| California jewelflower *Caulanthus californicus* | E/E/1B | Southern San Joaquin Valley, Carrizo Plains: Fresno, Kings*, Kern, Santa Barbara, San Luis Obispo, Tulare*, and Ventura* Counties | Annual grassland, chenopod scrub, pinyon and juniper woodland, in sandy or loamy soils | Feb-May |
| Coyote ceanothus *Ceanothus ferrisae* | E/--/1B | Northeastern San Francisco Bay: Mount Hamilton Range, Santa Clara County | Chaparral, coastal scrub, annual grassland, on serpentine soils | Jan-Mar |

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|---|---|---|---|---|
| Vail Lake ceanothus *Ceanothus ophiochilus* | T/E/1B | Northern Peninsular Ranges, near Vale Lake, Riverside County | Chaparral (gabbroic or pyroxenite-rich outcrops) | Feb-Mar |
| Pine Hill ceanothus *Ceanothus roderickii* | E/R/1B | Northern Sierra Nevada foothills: Pine Hill, western El Dorado County | Northern mixed chaparral, cismontane woodland, on gabbro soils | May-June |
| Catalina Island mountain-mahogany *Cercocarpus traskiae* | E/E/1B | Santa Catalina Island | Chaparral; coastal scrub; rocky, sausserite gabbro | Mar-May |
| Hoover's spurge *Chamaesyce hooveri* | T/--/1B | Central Valley, including Butte, Glenn, Merced, Stanislaus, Tehama, and Tulare Counties | Below the high-water marks of large northern hardpan and volcanic vernal pools | Jul |
| Purple amole *Chlorogalum purpureum* var. *purpureum* | PT/--/1B | Northeastern outer south Coast Ranges, eastern Santa Lucia Mountains: Monterey County | Cismontane woodland, valley and foothill grassland | May-Jun |
| Camatta Canyon amole *Chlorogalum purpureum* var. *reductum* | PT/R/1B | Southeastern outer south Coast Ranges, north slope La Panza Range: San Luis Obispo County | Cismontane woodland (serpentinite) | Apr-May |
| Howell's spineflower *Chorizanthe howellii* | E/T/1B | Central north coast: Mendocino County | Coastal dunes, coastal prairie, coastal scrub, sandy | May-Jul |
| Orcutt's spineflower *Chorizanthe orcuttiana* | E/E/1B | Southern south coast: Del Mar to Point Loma, San Diego County | Chaparral (maritime), closed-cone coniferous forest, coastal scrub, sandy openings | Mar-Apr |
| Monterey spineflower *Chorizanthe pungens* | T/--/1B | Monterey and Santa Cruz Counties | Coastal dunes | April-June |
| Ben Lomond spineflower *Chorizanthe pungens* var. *hartwegiana* | E/--/1B | Northern and central central coast: San Francisco Bay, Santa Cruz County | Lower montane coniferous forest (maritime ponderosa pine sandhills) | Apr-Jul |

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|---|---|---|---|---|
| Monterey spineflower *Chorizanthe pungens* var. *pungens* | T/--/1B | Northern and central coast: San Francisco Bay; Monterey, Santa Cruz, and San Luis Obispo* Counties | Chaparral (maritime), cismontane woodland, coastal dunes, coastal scrub, valley and foothill grassland, sandy | Apr-Jun |
| Scott's Valley spineflower *Chorizanthe robusta* var. *hartwegii* | E/--/1B | Scotts Valley in Santa Cruz County | Annual grassland, on soils derived from sedimentary rocks | April-July |
| Robust spineflower *Chorizanthe robusta* var. *robusta* | E/--/1B | Northeast central coast, southwest San Francisco Bay: Alameda*, Monterey, San Mateo*, Santa Clara*, and Santa Cruz Counties | Coastal bluff scrub, coastal dunes openings in cismontane woodland | May-Sep |
| Sonoma spineflower *Chorizanthe valida* | E/E/1B | Northern central coast: Point Reyes, Marin and Sonoma* Counties | Coastal prairie (sandy) | Jun-Aug |
| Ashland thistle *Cirsium ciliolatum* | --/E/2 | Klamath Ranges, Siskiyou County; Oregon | Cismontane woodland, valley and foothill grassland | Jun-Aug |
| Fountain thistle *Cirsium fontinale* var. *fontinale* | E/E/1B | Southwestern San Francisco Bay: San Mateo County | Chaparral (openings), valley and foothill grassland, serpentinite seeps | Jun-Oct |
| Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense* | E/E/1B | Central outer south Coast Ranges: San Luis Obispo County | Chaparral, cismontane woodland, serpentinite seeps | Feb-Jul |
| Suisun thistle *Cirsium hydrophilum* var. *hydrophilum* | E/--/1B | Deltaic central valley: Suisun Marsh, Solano County | Salt marsh | Jul-Sep |
| La Graciosa thistle *Cirsium loncholepis* | PT/T/1B | Southern central coast: Santa Barbara and San Luis Obispo Counties | Coastal dunes, brackish marsh | Jun-Aug |
| Surf thistle *Cirsium rhothophilum* | SC/T/1B | Southern central coast: Santa Barbara and San Luis Obispo Counties | Coastal bluff scrub, coastal dunes | Apr-Jun |

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|---|---|---|---|---|
| Presidio clarkia<br>*Clarkia franciscana* | E/E/1B | San Francisco Bay, Presidio, Oakland hills, Alameda and San Francisco Counties | Serpentine grassland, coastal scrub | May-July |
| Vine Hill clarkia<br>*Clarkia imbricata* | E/E/1B | Outer north Coast Ranges: Sonoma County | Chaparral, valley and foothill grassland, acidic sandy loam | Jun-Jul |
| Merced clarkia<br>*Clarkia lingulata* | SC/E/1B | Central Sierra Nevada foothills: Merced River Canyon, Mariposa County | Closed-cone coniferous forest, chaparral, cismontane woodland | May-Jun |
| Pismo clarkia<br>*Clarkia speciosa* ssp. *immaculata* | E/R/1B | Southern central coast: San Luis Obispo County | Chaparral (margins, openings), cismontane woodland, valley and foothill grassland, sandy | May-Jun |
| Springville clarkia<br>*Clarkia springvillensis* | PT/E/1B | Southern Sierra Nevada foothills: Springville, Tulare County | Chaparral, cismontane woodland, valley and foothill grassland, granitic | May-Jul |
| Saltmarsh bird's-beak<br>*Cordylanthus maritimus* ssp. *maritimus* | E/E/1B | South coast: Los Angeles, Orange, Santa Barbara, San Diego, San Luis Obispo, and Ventura Counties; Baja California | Coastal dunes, marshes and swamps (coastal salt) | May-Oct |
| Soft bird's-beak<br>*Cordylanthus mollis* ssp. *mollis* | E/R/1B | San Francisco Bay, Suisun Marsh, Contra Costa, Marin*, Napa, Sacramento*, Solano, and Sonoma* Counties | Salt marsh | Jul-Sep |
| Palmate-bracted bird's-beak<br>*Cordylanthus palmatus* | E/E/1B | Livermore Valley, Central Valley, including portions of Alameda, Colusa, Fresno, Madera*, San Joaquin*, and Yolo Counties | Alkali meadow, alkali scrub, chenopod scrub, alkaline flats | May-Oct |
| Seaside bird's-beak<br>*Cordylanthus rigidus* ssp. *littoralis* | SC/E/1B | Central and southern central coast: Monterey and Santa Barbara Counties | Coastal sage scrub | May-Sep |
| Pennell's bird's-beak<br>*Cordylanthus tenuis* ssp. *capillaris* | E/R/1B | Southwestern outer north Coast Ranges: Sonoma County | Closed-cone coniferous forest, chaparral, serpentinite | Jun-Jul |

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|---|---|---|---|---|
| Santa Cruz cypress *Cupressus abramsiana* | E/E/1B | Santa Cruz and San Mateo Counties | Closed-cone coniferous forest, lower montane coniferous forest, sandstone or granitic | |
| Gowen cypress *Cupressus goveniana* ssp. *goveniana* | T/--/1B | Monterey County | Closed-cone coniferous forest, chaparral (maritime) | |
| Baker's larkspur *Delphinium bakeri* | PE/R/1B | Marin and Sonoma Counties* | Coastal scrub | Mar-May |
| Yellow larkspur *Delphinium luteum* | PE/R/1B | Sonoma County | Chaparral, coastal prairie, coastal scrub | Mar-May |
| San Clemente Island larkspur *Delphinium variegatum* ssp. *kinkiense* | E/E/1B | San Clemente Island | Valley and foothill grassland (coastal) | Mar-Apr |
| Geysers's dichanthelium *Dichanthelium lanuginosum* var. *thermale* | SC/E/1B | Sonoma County | Closed-cone coniferous forest, riparian forest, valley and foothill grassland, hydrothermally-altered soil | Jun-Aug |
| Beach spectaclepod *Dithyrea maritima* | SC/T/1B | Los Angeles*, Santa Barbara, and San Luis Obispo Counties; Santa Catalina Islsand*, San Miguel Island*, San Nicolas Island; Baja California | Coastal dunes, coastal scrub (sandy) | Mar-May |
| Slender-horned spineflower *Dodecahema leptoceras* | E/E/1B | Los Angeles, Riverside, and western San Bernardino Counties | Coastal sage scrub, on flood deposited terraces and washes, below 2,200 feet | April-June |
| Slender-horned spineflower *Dodecahema leptoceras* | E/E/1B | Los Angeles, Riverside, and San Bernardino Counties | Chaparral, coastal scrub (alluvial fan), sandy | Apr-Jun |
| Cuyamaca Lake downingia *Downingia conco lor* var. *brevior* | SC/E/1B | San Diego County | Meadows (vernally mesic), vernal pools | May-Jul |

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Table F-1. Continued

| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Conejo dudleya<br>*Dudleya abramsii* ssp. *parva* | T/--/1B | Ventura County | Coastal scrub; valley and foothill grassland; rocky, clay | May-Jun |
| Short-leaved dudleya<br>*Dudleya blochmaniae* ssp. *brevifolia* | SC/E/1B | San Diego County | Chaparral (maritime, openings), coastal scrub, Torrey sandstone | Apr |
| Marcescent dudleya<br>*Dudleya cymosa* ssp. *marcescens* | T/R/1B | Los Angeles and Ventura Counites | Chaparral (volcanic) | Apr-Jun |
| Santa Monica Mtns. dudleya<br>*Dudleya cymosa* ssp. *dvatifolia* | T/--/1B | Los Angeles, Orange, and Ventura Counites | Chaparral, coastal scrub, volcanic | Mar-Jun |
| Santa Cruz Island dudleya<br>*Dudleya nesiotica* | T/R/1B | Santa Cruz Island | Coastal bluff scrub, coastal scrub, rocky or gravelly, clay | Apr-Jun |
| Santa Clara Valley dudleya<br>*Dudleya setchellii* | E/--/1B | Santa Clara County | Cismontane woodland; valley and foothill grassland; serpentinite, rocky | May-Jun |
| Laguna Beach dudleya<br>*Dudleya stolonifera* | PE/T/1B | Orange County | Chaparral, cismontane woodland, coastal scrub, valley and foothill grassland, rocky soils | May-Jul |
| Santa Barbara Island dudleya<br>*Dudleya traskiae* | E/E/1B | Santa Barbara Island | Coastal bluff scrub, coastal scrub, rocky | Feb-Jul |
| Verity's dudleya<br>*Dudleya verityi* | T/--/1B | Ventura County | Chaparral, cismontane woodland, coastal scrub, volcanic | May-Jun |
| Kern mallow<br>*Eremalche parryi* | E/--/1B | Vicinity of Lokern, Kern County | Valley sink scrub, saltbush scrub, on sandy clay-loam soils, between 600-900 feet | April-May |
| Santa Ana River woollystar<br>*Eriastrum densifolium* ssp. *sanctorum* | E/E/1B | Orange*, Riverside, and San Bernardino Counties | Chaparral, coastal scrub (alluvial fan), sandy or gravelly, at 1,240 - 1,900 feet | Jun-Sep |

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|---|---|---|---|---|
| Hoover's eriastrum *Eriastrum hooveri* | T/--/4 | Fresno, Kings, Kern, Santa Barbara, San Benito, San Luis Obispo, and Tulare Counties | Chenopod scrub, pinyon and juniper woodland, valley and foothill grassland | Mar-Jul |
| Parish's daisy *Erigeron parishii* | T/--/1B | Riverside and San Bernardino Counties | Mohavean Desert scrub, pinyon and juniper woodland, usually carbonate | May-Jun |
| Indian knob mountainbalm *Eriodictyon altissimum* | E/E/1B | San Luis Obispo County | Chaparral (maritime), cismontane woodland, sandstone | Mar-Jun |
| Trinity buckwheat *Eriogonum alpinum* | SC/E/1B | Siskiyou and Trinity Counties | Alpine boulder and rock field; subalpine coniferous forest; upper montane coniferous forest; serpentinite, rocky | Jun-Sep |
| Ione buckwheat *Eriogonum apricum* var. *apricum* | PE/E/1B | Amador County | Chaparral (openings, Ione soil) | Jul-Oct |
| Irish Hill buckwheat *Eriogonum apricum* var. *prostratum* | PE/E/1B | Amador County | Chaparral (openings, Ione soil) | Jun-Jul |
| Thorne's buckwheat *Eriogonum ericifolium* var. *thornei* | SC/E/1B | San Bernardino County | Pinyon and juniper woodland (gravelly) | Jul-Aug |
| San Nicolas Island buckwheat *Eriogonum grande* var. *timorum* | SC/E/1B | San Nicolas Island | Coastal bluff scrub | Mar-Oct |
| Kellogg's buckwheat *Eriogonum kelloggii* | C/E/1B | Red Mountain, Mendocino County | Lower montane coniferous forest (rocky, serpentinite) | May-Aug |
| Southern mountain buckwheat *Eriogonum kennedyi* var. *austromontanum* | PT/--/1B | San Bernardino County | Lower montane coniferous forest (gravelly), pebble plain | Jul-Sep |

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|---|---|---|---|---|
| Cushenbury buckwheat *Eriogonum ovalifolium* var. *vineum* | E/--/1B | San Bernardino County | Joshua tree woodland, Mohavean Desert scrub, pinyon and juniper woodland, carbonate | May-Aug |
| San Mateo woolly sunflower *Eriophyllum latilobum* | E/E/1B | San Mateo County | Cismontane woodland (serpentinite, often on roadcuts) | May-Jun |
| San Diego button-celery *Eryngium aristulatum* var. *parishii* | E/E/1B | Riverside and San Diego Counties; Baja California | Coastal scrub, valley and foothill grassland, vernal pools, mesic | Apr-Jun |
| Loch Lomond button-celery *Eryngium constancei* | E/E/1B | Lake and Sonoma Counties | Vernal pools | Apr-Jun |
| Delta button-celery *Eryngium racemosum* | SC/E/1B | San Joaquin River delta and floodplains; Calaveras, Merced, San Joaquin*, and Stanislaus Counties | Riparian scrub (vernally mesic clay depressions) | Jun-Aug |
| Contra Costa wallflower *Erysimum capitatum* ssp. *angustatum* | E/E/1B | Contra Costa County | Inland dunes | Mar-Jul |
| Humboldt Bay wallflower *Erysimum menziesii* ssp. *eurekense* | E/E/1B | Humboldt County | Coastal dunes | Mar-Apr |
| Menzies's wallflower *Erysimum menziesii* ssp. *menziesii* | E/E/1B | North coast: Mendocino and Monterey County | Coastal dunes, coastal scrub | Mar-Jun |
| Yadon's wallflower *Erysimum menziesii* ssp. *yadonii* | E/E/1B | Monterey County | Coastal dunes | Jun-Aug |
| Santa Cruz wallflower *Erysimum teretifolium* | E/E/1B | Santa Cruz County | Chaparral, lower montane coniferous forest, inland marine sands | Mar-Jul |
| Pine Hill flannelbush *Fremontodendron decumbens* | E/R/1B | Pine Hill (El Dorado County) near Grass Valley (Nevada County) | Gabbro or serpentine chaparral, woodland | April-July |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Mexican flannelbush *Fremontodendron mexicanum* | E/R/1B | San Diego and Imperial Counties | Chaparral, oak woodland, closed-cone coniferous forest, along creeks or in dry canyons | March-June |
| Roderick's fritillary *Fritillaria roderickii* | --/E/1B | Mendocino County | Coastal bluff scrub, coastal prairie, valley and foothill grassland | Mar-May |
| Striped adobe-lily *Fritillaria striata* | PT/T/1B | Southeastern San Joaquin Valley, western Sierra Nevada foothills, northern foothills of the Tehachapi Mountains, Kern and Tulare Counties | Cismontane woodland, valley and foothill grassland, usually clay, between 1,000-4,000 feet | Feb-Apr |
| Box bedstraw *Galium buxifolium* | E/R/1B | Santa Cruz Island, San Miguel Island | Coastal bluff scrub, closed-cone coniferous forest, coastal scrub, rocky | Mar-Jul |
| El Dorado bedstraw *Galium californicum* ssp. *sierrae* | E/R/1B | El Dorado County | Chaparral, cismontane woodland, lower montane coniferous forest, gabbroic | May-Jun |
| San Clemente Island bedstraw *Galium catalinense* ssp. *acrispum* | SC/E/1B | San Clemente Island | Valley and foothill grassland | Mar-Aug |
| Sand gilia *Gilia tenuiflora* ssp. *arenaria* | E/T/1B | Monterey County | Chaparral (maritime), cismontane woodland, coastal dunes, coastal scrub, sandy | Apr-Jun |
| Hoffmann's slender-flowered gilia *Gilia tenuiflora* ssp. *hoffmannii* | E/--/1B | Santa Rosa Island | Coastal dunes, coastal scrub | Apr-May |
| Bogg's Lake hedge-hyssop *Gratiola heterosepala* | --/E/1B | Fresno, Lake, Lassen, Madera, Modoc, Placer, Sacramento, Shasta, San Joaquin, Solano, and Tehama Counties; Oregon | Marshes and swamps (lake margins), vernal pools, clay | Apr-Aug |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Ash Meadows gumplant *Grindelia fraxino-pratensis* | T/--/1B | Inyo County; Nevada | Meadows (mesic clay) | Jun-Oct |
| Island rush-rose *Helianthemum greenei* | T/--/1B | San Clemente Island, Santa Cruz Island, San Miguel Island, Santa Rosa Island*(?) | Closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, rocky | Mar-Jul |
| Algodones Dunes sunflower *Helianthus niveus* ssp. *tephrodes* | SC/E/1B | Imperial County; Arizona, Sonora, Mexico | Desert dunes | Sep-May |
| Otay tarplant *Hemizonia conjugens* | T/E/1B | San Diego County; Baja California | Coastal scrub, valley and foothill grassland, clay | May-Jun |
| Gaviota tarplant *Hemizonia increscens* ssp. *villosa* | C/E/1B | Santa Barbara County | Coastal bluff scrub, Coastal scrub, valley and foothill grassland | Jun-Sep |
| Mojave tarplant *Hemizonia mohavensis* | SC/E/1A | Riverside, San Bernardino*, and San Diego Counties | Chaparral (mesic), riparian scrub | Jul-Oct |
| Marin western flax *Hesperolinon congestum* | T/T/1B | Marin, San Francisco, and San Mateo Counties | Chaparral, valley and foothill grassland, serpentinite | May-Jul |
| Lake County western flax *Hesperolinon didymocarpum* | SC/E/1B | Lake County | Chaparral, cismontane woodland, valley and foothill grassland, serpentinite | May-Jul |
| Santa Cruz tarplant *Holocarpha macradenia* | PT/E/1B | Coastal California from San Luis Obispo County to Marin County | Coastal prairie and annual grasslands, on sandy clay soils | June-October |
| Water howellia *Howellia aquatilis* | T/--/1A | Mendocino*, Idaho, Oregon*, Washington | Marshes and swamps (freshwater) | Jun |
| Burke's goldfields *Lasthenia burkei* | E/E/1B | Lake, Mendocino, and Sonoma Counties | Meadows (mesic), vernal pools | Apr-Jun |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Contra Costa goldfields *Lasthenia conjugens* | E/--/1B | Alameda, Contra Costa, Mendocino*, Napa, Santa Barbara*, Santa Clara*, and Solano Counites | Cismontane woodland, playas (alkaline), valley and foothill grassland, vernal pools, mesic, below 700 feet | Mar-Jun |
| Beach layia *Layia carnosa* | E/E/1B | Humboldt, Monterey, Marin, Santa Barbara*, San Francisco* Counties | Coastal dunes, coastal scrub (sandy) | Apr-Jul |
| San Joaquin woollythreads *Lembertia congdonii* | E/--/1B | Fresno, Kings, Kern, Santa Barbara, San Benito, San Luis Obispo, and Tulare* Counties | Chenopod scrub, valley and foothill grassland, alkaline or loamy soils | Feb-May |
| San Bernardino Mtns. bladderpod *Lesquerella kingii* ssp. *bernardina* | E/--/1B | San Bernardino County | Lower montane coniferous forest, pinyon and juniper woodland, usually carbonate | May-Jun |
| San Francisco lessingia *Lessingia germanorum* | E/E/1B | San Francisco and San Mateo Counties | Coastal scrub (remnant dunes) | Jun-Nov |
| Western lily *Lilium occidentale* | E/E/1B | Del Norte and Humboldt Counties, Oregon | Bogs and fens, coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps (freshwater), north coast coniferous forest (openings) | Jun-Jul |
| Pitkin Marsh lily *Lilium pardalinum* ssp. *pitkinense* | PE/E/1B | Sonoma County | Cismontane woodland; meadows; marshes and swamps (freshwater); mesic, sandy | Jun-Jul |
| Point Reyes meadowfoam *Limnanthes douglasii* ssp. *sulphurea* | SC/E/1B | Marin and San Mateo Counties | Coastal prairie, meadows (mesic), marshes and swamps (freshwater), vernal pools | Mar-May |
| Butte County meadowfoam *Limnanthes floccosa* ssp. *californica* | E/E/1B | Butte County | Valley and foothill grassland (mesic), vernal pools | Mar-May |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Parish's meadowfoam *Limnanthes gracilis* ssp. *parishii* | SC/E/1B | Riverside and San Diego Counties | Meadows (vernally mesic), vernal pools | Apr-Jun |
| Sebastopol meadowfoam *Limnanthes vinculans* | E/E/1B | Napa(?) and Sonoma Counties | Meadows, valley and foothill grassland, vernal pools, vernally mesic | Apr-May |
| San Clemente Island woodland star *Lithophragma maximum* | PE/E/1B | San Clemente Island | Coastal bluff scrub, coastal scrub, rocky | Apr-Jun |
| San Clemente Island bird's-foot trefoil *Lotus argophyllus* var. *adsurgens* | SC/E/1B | San Clemente Island | Coastal bluff scrub, coastal scrub, rocky | Apr-Jun |
| Santa Cruz Island bird's-foot trefoil *Lotus argophyllus* var. *niveus* | SC/E/1B | Santa Cruz Island | Coastal bluff scrub, chaparral, coastal scrub, rocky | Mar-Sep |
| San Clemente Island lotus *Lotus dendroideus* var. *traskiae* | E/E/1B | San Clemente Island | Coastal bluff scrub, coastal scrub, valley and foothill grassland | Feb-Aug |
| Mariposa lupine *Lupinus citrinus* var. *deflexus* | PE/T/1B | Mariposa County | Chaparral, cismontane woodland, granitic | Apr-May |
| Milo Baker's lupine *Lupinus milo-bakeri* | SC/T/1B | North Coast Ranges: Colusa and Mendocino Counties | Cismontane woodland (often along roadsides), valley and foothill grassland | Jun-Sep |
| Nipomo Mesa lupine *Lupinus nipomensis* | C/E/1B | San Luis Obispo County | Coastal dunes | Mar-May |
| Tidestrom's lupine *Lupinus tidestromii* | E/E/1B | Monterey, Marin, and Sonoma Counties | Coastal dunes | May-Jun |
| San Clemente Island bush mallow *Malacothamnus clementinus* | E/E/1B | San Clemente Island | Valley and foothill grassland (rocky) | Mar-Aug |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Santa Cruz Island bush mallow *Malacothamnus fasciculatus* var. *nesioticus* | E/E/1B | Santa Cruz Island | Chaparral, coastal scrub, rocky | Apr-Jul |
| Santa Cruz Island cliff-aster *Malacothrix indecora* | E/--/1B | Santa Cruz Island, San Miguel Island | Coastal bluff scrub, chaparral, coastal dunes, coastal scrub | Apr-Sep |
| Island malacothrix *Malacothrix squalida* | E/--/1B | Amacapa Island, Santa Cruz Island | Coastal bluff scrub, chaparral, cismontane woodland | Apr-Jul |
| Kelso Creek monkeyflower *Mimulus shevockii* | PE/--/1B | Kern County | Joshua tree woodland, pinyon and juniper woodland, sandy, granitic | Mar-May |
| Willowy monardella *Monardella linoides* ssp. *viminea* | E/E/1B | San Diego County; Baja California | Closed-cone coniferous forest, chaparral, riparian forest, riparian scrub, riparian woodland | Jun-Aug |
| Spreading navarretia *Navarretia fossalis* | T/--/1B | Riverside and San Diego Counties; Baja California | Chenopod scrub, marshes and swamps (assorted shallow freshwater), playas, vernal pools | Apr-Jun |
| Few-flowered navarretia *Navarretia leucocephala* ssp. *pauciflora* | E/T/1B | Lake and Napa Counties | Vernal pools (volcanic ash flow) | May-Jun |
| Many-flowered navarretia *Navarretia leucocephala* ssp. *plieantha* | E/E/1B | Lake and Sonoma Counties | Vernal pools (volcanic ash flow) | May-Jun |
| Piute Mtns. navarretia *Navarretia setiloba* | PT/--/1B | Kern and Tulare Counties | Cismontane woodland, pinyon and juniper woodland, valley and foothill grassland, clay or gravelly loam | Apr-Jun |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Colusa grass *Neostapfia colusana* | T/E/1B | Colusa*, Merced, Solano, Stanislaus, asnd Yolo Counties | Vernal pools (adobe) | May-Aug |
| Amargosa nitrophila *Nitrophila mohavensis* | E/E/1B | Inyo County; Nevada | Playas (mesic, clay) | May-Oct |
| Dehesa nolina *Nolina interrata* | --/E/1B | San Diego County; Baja California | Chaparral (gabbroic, metavolcanic, or serpentinite) | Jun-Jul |
| Eureka Dunes evening-primrose *Oenothera californica* ssp. *eurekensis* | E/R/1B | Inyo County | Desert dunes | Apr-Jul |
| Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii* | E/E/1B | Contra Costa County | Inland dunes | Mar-Sep |
| Bakersfield cactus *Opuntia basilaris* var. *treleasei* | E/E/1B | Southern San Joaquin Valley in Kern County | Chenopod scrub, cismontane woodland, valley and foothill grassland, sandy or gravelly, between 500-1,800 feet | May |
| California Orcutt grass *Orcuttia californica* | E/E/1B | Scattered occurrences in southwest California: Los Angeles, Riverside, San Diego, and Ventura Counties; Baja California | Vernal pools | Apr-Aug |
| San Joaquin Valley Orcutt grass *Orcuttia inaequalis* | T/E/1B | Scattered locations along east edge of the San Joaquin Valley and adjacent foothills: Fresno, Madera, Merced, Stanislaus*, and Tulare* Counites | Vernal pools | Apr-Sep |
| Hairy Orcutt grass *Orcuttia pilosa* | E/E/1B | Scattered locations along east edge of the Central Valley and adjacent foothills: Butte, Glenn, Madera, Merced, Stanislaus, and Tehama Counites | Vernal pools | May-Sep |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Slender Orcutt grass<br>*Orcuttia tenuis* | T/E/1B | Sierra Nevada and Cascade Range foothills: Lake, Lassen, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties | Vernal pools | May-Oct |
| Sacramento Orcutt grass<br>*Orcuttia viscida* | E/E/1B | Sacramento County | Vernal pools | May-Jun |
| Cushenbury oxytheca<br>*Oxytheca parishii* var. *goodmaniana* | E/--/1B | San Bernardino County | Pinyon and juniper woodland (carbonate, talus) | May-Sep |
| Lake County stonecrop<br>*Parvisedum leiocarpum* | E/E/1B | Lake County | Cismontane woodland, valley and foothill grassland, vernal pools, vernally mesic depressions in volcanic outcrops | Apr-May |
| White-rayed pentachaeta<br>*Pentachaeta bellidiflora* | E/E/1B | Marin*, Santa Cruz*, and San Mateo Counties | Valley and foothill grassland (often serpentinite) | Mar-May |
| Lyon's pentachaeta<br>*Pentachaeta lyonii* | E/E/1B | Los Angeles and Ventura Counties, Santa Catalina Island(?)* | Chaparral (openings), valley and foothill grassland | Mar-Aug |
| Northern Channel Islands phacelia<br>*Phacelia insularis* var. *insularis* | E/--/1B | San Miguel Island, San Rosa Island | Coastal dunes, valley and foothill grassland | Mar-Apr |
| Yreka phlox<br>*Phlox hirsuta* | C/E/1B | Siskiyou County | Lower montane coniferous forest, upper montane coniferous forest, serpentinite talus | Apr-Jun |
| Yadon's rein orchid<br>*Piperia yadonii* | PE/--/1B | Monterey County | Coastal bluff scrub, closed-cone coniferous forest, chaparral (maritime), sandy | May-Aug |
| San Francisco popcorn-flower<br>*Plagiobothrys diffusus* | SC/E/1B | Santa Cruz and San Francisco* Counties | Coastal prairie, valley and foothill grassland? | Apr-Jun |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Calistoga popcorn-flower *Plagiobothrys strictus* | PE/T/1B | Napa County | Broadleafed upland forest, meadows, valley and foothill grassland, vernal pools, alkaline areas near thermal springs | Mar-Jun |
| San Bernardino blue grass *Poa atropurpurea* | PE/--/1B | San Bernardino and San Diego Counties | Meadows (mesic) | Apr-Aug |
| Napa blue grass *Poa napensis* | PE/E/1B | Napa County | Meadows, valley and foothill grassland, alkaline, near hot springs | May-Aug |
| San Diego mesa mint *Pogogyne abramsii* | E/E/1B | San Diego County | Vernal pools | Apr-Jun |
| Santa Lucia mint *Pogogyne clareana* | SC/E/1B | Monterey County | Riparian woodland | May-Jun |
| Otay Mesa mint *Pogogyne nudiuscula* | E/E/1B | San Diego County; Baja California(?)* | Vernal pools | May-Jun |
| Hickman's cinquefoil *Potentilla hickmanii* | PE/E/1B | Monterey, San Mateo, and Sonoma* Counties | Coastal bluff scrub, closed-cone coniferous forest, meadows (vernally mesic), marshes and swamps (freshwater) | Apr-Aug |
| Hartweg's golden sunburst *Pseudobahia bahiifolia* | E/E/1B | Eastern side of Sacramento-San Joaquin Valleys, formerly as far north as Yuba County | Rocky, bare areas along rolling hills, adjavent to vernal pools, usually with heavy clay soils | Mar-Apr |
| San Joaquin adobe sunburst *Pseudobahia peirsonii* | T/E/1B | Fresno, Kern, and Tulare Counties | Cismontane woodland, valley and foothill grassland, adobe clay | Mar-Apr |
| Parish's alkali-grass *Puccinellia parishii* | PE/--/1B | Kern(?) and San Bernardino Counties; Arizona; New Mexico | Meadows (alkaline springs and seeps), at 2,300-6,000 feet | Apr-May |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Gambel's water cress *Rorippa gambellii* | E/T/1B | Los Angeles*, Orange*, Santa Barbara*, San Bernardino*, San Diego(?)*, and San Luis Obispo Counties; Baja California | Marshes and swamps (freshwater or brackish) | Apr-Sep |
| Tahoe yellow cress *Rorippa subumbellata* | SC/E/1B | El Dorado, Nevada*, and Placer Counties | Lower montane coniferous forest, meadows, decomposed granitic beaches | May-Sep |
| Small-leaved rose *Rosa minutifolia* | SC/E/2 | San Diego County; Baja California | Chaparral, coastal scrub | Jan-Jun |
| Layne's butterweed *Senecio layneae* | T/R/1B | El Dorado and Tuolumne Counties | Chaparral and foothill woodland, on serpentine or gabbro soils | April-July |
| Layne's ragwort *Senecio layneae* | T/R/1B | El Dorado and Tuolumne Counites | Chaparral, cismontane woodland, serpentinite or gabbroic, rocky | Apr-Jul |
| Santa Cruz Island rock cress *Sibara filifolia* | E/--/1B | San Clemente Island, Santa Catalina Island*, and Santa Cruz Island* | Coastal scrub (rocky, volcanic) | Mar-Apr |
| Owens Valley checkerbloom *Sidalcea covillei* | SC/E/1B | Inyo County | Great Basin scrub, meadows (alkaline, mesic) | Apr-Jun |
| Keck's checkerbloom *Sidalcea keckii* | PE/--/1B | Tulare and Fresno(?)* Counties | Cismontane woodland, valley and foothill grassland, serpentinite | Apr |
| Kenwood Marsh checkerbloom *Sidalcea oregana* ssp. *valida* | PE/E/1B | Sonoma County | Marshes and swamps (freshwater) | Jun-Sep |
| Bird-foot checkerbloom *Sidalcea pedata* | E/E/1B | San Bernardino County | Meadows (mesic), pebble plain | May-Aug |
| Scadden Flat checkerbloom *Sidalcea stipularis* | SC/E/1B | Two occurrences near Scadden Flat (Nevada County) | Freshwater seep; wet meadow | July-August |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Red Mountain catchfly *Silene campanulata* ssp. *campanulata* | C/E/1B | North Coast Ranges, Colusa and Mendocino Counties | Chaparral, lower montane coniferous forest, serpentinite, rocky | May-Jun |
| Metcalf Canyon jewel-flower *Streptanthus albidus* ssp. *albidus* | E/--/1B | Santa Clara County | Valley and foothill grassland (serpentinite) | Apr-Jul |
| Tiburon jewel-flower *Streptanthus niger* | E/E/1B | Marin County | Valley and foothill grassland (serpentinite) | May-Jun |
| California seablite *Suaeda californica* | E/--/1B | Alameda* and Santa Clara* Counties; Morro Bay, San Luis Obispo; historically found in south San Francisco Bay | Marshes and swamps (coastal salt) | Jul-Oct |
| Eureka Valley dune grass *Swallenia alexandrae* | E/R/1B | Inyo County | Desert dunes | Apr-Jun |
| California dandelion *Taraxacum californicum* | PE/--/1B | San Bernardino County | Meadows (mesic) | May-Aug |
| Slender-petaled thelypodium *Thelypodium stenopetalum* | E/E/1B | San Bernardino County | Meadows (mesic, alkaline) | May-Aug |
| Santa Cruz Island fringepod *Thysanocarpus conchuliferus* | E/--/1B | Santa Cruz Island | Chaparral, cismontane woodland, rocky | Mar-May |
| Hidden Lake bluecurls *Trichostema austromontanum* ssp. *compactum* | PT/--/1B | Riverside County | Upper montane coniferous forest, seasonally submerged lake margins | Jul-Sep |
| Showy Indian clover *Trifolium amoenum* | E/--/1B | Coast Range foothills from Mendocino to Santa Clara County | Low elevation grasslands, including swals and disturbed areas | Apr-Jun |
| Monterey clover *Trifolium trichocalyx* | PE/E/1B | Monterey County | Closed-cone coniferous forest (openings, burned areas) | Apr-Jun |

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| Common and Scientific Name | Legal Status[a] Federal/State/CNPS | Geographic Distribution | Habitat Requirements | Identification Period |
|---|---|---|---|---|
| Greene's tuctoria *Tuctoria greenei* | E/R/1B | Scattered distribution along east edge of the Central Valley from Tehama to Merced County; Fresno, Madera, San Joaquin, Stanislaus, and Tulare Counties | Vernal pools | May-Jul |
| Crampton's tuctoria *Tuctoria mucronata* | E/E/1B | Solano and Yolo Counties | Valley and foothill grassland (mesic), vernal pools | Apr-Jul |
| California vervain *Verbena californica* | PT/T/1B | Tuolumne County | Cismontane woodland, valley and foothill grassland (mesic), usually serpentinite seeps or creeks | May-Sep |
| Crownbeard *Verbesina dissita* | T/T/1B | Orange County; Baja California | Chaparral (maritime), coastal scrub | Apr-Jul |

[a] Status explanations:

**Federal**

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PE = proposed for federal listing as endangered under the federal Endangered Species Act.
PT = proposed for federal listing as threatened under the federal Endangered Species Act.
C = species for which USFWS has on file sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list.
SC = species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.
-- = no listing.

**State**

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
R = listed as rare under the California Native Plant Protection Act. This category is no longer used for newly listed plants, but some plants previously listed as rare retain this designation.
-- = no listing.

* = extirpated from that area, (?) = uncertain whether occurs in that area.

**California Native Plant Society**

| | | |
|---|---|---|
| 1A | = | List 1A species: presumed extinct in California. |
| 1B | = | List 1B species: rare, threatened, or endangered in California and elsewhere. |
| 2 | = | List 2 species: rare, threatened, or endangered in California but more common elsewhere. |
| 4 | = | List 4 species: plants of limited distribution. |

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Table F-2. California Special-Status Wildlife Species



| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Trinity bristlesnail (=California northern river snail) *Monadenia setosa* | SC/T | Swede Creek, tributary to Trinity River, Trinity County | On moss and in forest duff accumulated under trees on more stable portions of talus slopes |
| Morro shoulderband (=banded dune snail) *Helminthoglypta walkeriana* | E/-- | Restricted to Morro Bay and Montana de Oro State Parks | Data not available |
| Longhorn fairy shrimp *Branchinecta longiantenna* | E/-- | Eastern margin of central Coast Ranges from Contra Costa County to San Luis Obispo County | Small, clear pools in sandstone rock outcrops of clear to moderately turbid clay- or grass-bottomed pools |
| Conservancy fairy shrimp *Branchinecta conservatio* | E/-- | Disjunct occurrences in Solano, Merced, Tehama, Butte, and Glenn Counties | Large, deep vernal pools in annual grasslands |
| Vernal pool fairy shrimp *Branchinecta lynchi* | T/-- | Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County; isolated populations also in Riverside County | Common in vernal pools; also found in sandstone rock outcrop pools |
| San Diego fairy shrimp *Branchinecta sandiegonensis* | E/-- | San Diego County and northwestern Baja California | Vernal pools |
| Vernal pool tadpole shrimp *Lepidurus packardi* | E/-- | Shasta County south to Merced County | Vernal pools and ephemeral stock ponds |
| Riverside fairy shrimp *Streptocephalus woottoni* | E/-- | Southwestern Riverside County, Orange and San Diego Counties | Vernal pools |
| Shasta (=placid) crayfish *Pacifastacus fortis* | E/E | Pit River drainage in Shasta County, including tributaries of the Hat Creek and Fall River subdrainages | Streams |
| California freshwater shrimp *Syncaris pacifica* | E/-- | Coastal lowland streams in Napa, Marin, and Sonoma Counties | Streams |
| Valley elderberry longhorn beetle *Desmocerus californicus dimorphus* | T/-- | Streamside habitats below 3,000 feet through the Central Valley of California | Riparian and oak savanna habitats with elderberry shrubs; elderberries are host plant |
| Delta green ground beetle *Elaphrus viridus* | T/-- | Restricted to Olcott Lake and other vernal pools at Jepson Prairie Preserve, Solano County | Sparsely vegetated edges of vernal lakes and pools |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Mount Hermon (=barbate) June beetle *Polyphylla barbata* | E/-- | Santa Cruz Mountains | Occurs on Zaxante soils, typically in Ponderosa Pine sand parklands |
| Delhi Sands flower-loving fly *Rhaphiomidas terminatus abdominalis* | E/-- | Delhi sand dunes; 10 known populations | Sand, California buckwheat for feeding and lays eggs in sand near telegraph weed |
| Kern primrose sphinx moth *Euproserpinus euterpe* | T/-- | Walker Basin, Kern County | Dry, disturbed, sandy-gravelly washes adjacent to fallow fields where its larval food plant, the evening primrose, occurs |
| El Segundo blue *Euphilotes (= Shijimiaeoides) battoides allyni* | E/-- | Although once more widespread, now restricted to two sites: approximately 270 acres at Los Angeles International Airport and approximately 1.3 acres at the Chevron refinery in El Segundo | Native vegetated sand dune habitats with its host plant, *Eriogonum parvifolium* |
| Lange's metalmark *Apodemia mormo langei* | E/-- | Once occupied the Antioch Dunes; range now reduced to less than 10 acres in Contra Costa County | Limited to dense to moderately dense patches of food plant, wild buckwheat, in stabilized sand dunes |
| Palos Verdes blue butterfly *Glaucopsyche lydamus palosverdesensis* | E/-- | Palos Verde Peninsula, Los Angeles County | Lupines, wild peas, and vetch |
| Mission blue *Icaricia icarioides missionensis* | E/-- | San Bruno Mountain, San Mateo County; Twin Peaks, San Francisco County | Hill and ridgetops, as well as slopes with south exposure with caterpillar food plants, *Lupinus* spp. |
| San Bruno elfin *Callophrys mossii bayensis* | E/-- | San Bruno Mountain, Montara Mountains, and northern end of Santa Cruz Mountains, San Mateo County | North-facing slopes and ridges facing Pacific Ocean from 600 to 1,100 feet |
| Lotis blue *Lycaeides argyrognomon lotis* | E/-- | In and around a few sphagnum bogs near Mendocino, Mendocino County; Mendocino Pygmy Forest | Coastal peat bogs and pygmy conifer forest inland from coastal sand dunes |
| Smith's blue *Euphilotes (=Shijimiaeoides) enoptes smithi* | E/-- | Localized populations along the immediate coast and in coastal canyons of Monterey County; single populations reported in Santa Cruz and San Mateo Counties | Coastal dunes and hillsides that support seacliff buckwheat (*Eriogonum parvifolium*) or coast buckwheat (*Eriogonum latifolium*); these plants used as a nectar source for adults and host plant for larvae |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Bay checkerspot butterfly *Euphydryas editha bayensis* | T/-- | Vicinity of San Francisco Bay | Native grasslands on outcrops of serpentine soil; California plantain and owl's clover are host plants |
| Quino checkspot butterfly *Euphydryas editha quino* (=*wrighti*) | E/-- | Portions of Riverside and San Diego Counties | Locally distributed in sunny openings in chaparral and coastal sage shrublands |
| Oregon silverspot butterfly *Speyeria zerene hippolyta* | T/-- | No information | No information |
| Myrtle's silverspot butterfly *Speyeria zerene myrtleae* | E/-- | Coastal Marin and San Mateo Counties | Typically found in forests |
| Laguna Mountains skipper *Pyrgus ruralis lagunae* | E/-- | Laguna Mountains, Mount Palomar, San Diego County | High-elevation mountain habitats |
| Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum* | E/E | Small populations and breeding sites in southern Santa Cruz County and northern Monterey County | Lifetime spent mostly underground in willow groves, coastal scrub, coast live oak, or riparian habitats; migrates to breeding ponds in early to late winter, and juveniles disperse from the pond in September |
| Siskiyou Mountains salamander *Plethodon stormi* (=*P. elongatus s.*) | SC/T | In California, occurs only in Siskiyou County in drainages near the Applegate River, Deid Creek, and Horse Creek; Siskiyou Mountains of southern Oregon and northern California | A fully terrestrial salamander with no larval stage; requires humid conditions to survive and reproduce; found at elevations from 1,600 to 3,500 feet associated with talus slopes and north- and east-facing slopes |
| Desert slender salamander *Batrachoseps aridus* | E/E | Riverside County | Occurs beneath limestone slabs and talus and in crevices in moist soil on canyon walls |
| Kern Canyon slender salamander *Batrachoseps simatus* | SC/T | Restricted to the lower Kern River Canyon, Kern County | Under rocks, logs, large rock slides, and talus on north-facing slopes |
| Tehachapi slender salamander *Batrachoseps stebbinsi* | SC/T | Restricted to the Tehachapi Mountains, Kern County | North-facing talus slopes in valley-foothill hardwood, mixed conifer, and valley-foothill riparian habitats |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Shasta salamander *Hydromantes shastae* | SC/T | Restricted to several tributaries of the McCloud River, Pit River, and Squaw Creek, Shasta County | Limestone caves at elevations from 1,000 to 3,000 feet |
| Limestone salamander *Hydromantes brunus* | SC/T | Merced River Canyon near Briceburg, along the Bear Creek, and near Lake McClure, all in Mariposa County | Limestone outcrops and talus slopes in the foothill pine-chaparral belt |
| Arroyo southwestern toad *Bufo microscaphus californicus* | E/SSC, FP | Along the coast and foothills from San Luis Obispo County to San Diego County and inland to San Bernardino County | Prefers sandy arroyos and river bottoms with open riparian vegetation in inland valleys and foothills; also may use flooded agricultural fields and irrigation ditches |
| California red-legged frog *Rana aurora draytoni* | T/SSC, FP | Found along the coast and coastal mountain ranges of California from Humboldt County to San Diego County; Sierra Nevada from Butte County to Fresno County | Permanent and semipermanent aquatic habitats, such as creeks and coldwater ponds, with emergent and submergent vegetation and riparian species along the edges; may estivate in rodent burrows or cracks during dry periods |
| Desert tortoise *Gopherus (=Xerobates, =Scaptochelys) agassizii* | T/T | Southern California deserts in Inyo, San Bernardino, Kern, Los Angeles, Riverside, San Diego, and Imperial Counties | Desert areas from 300 to 900 feet with sandy loam to gravelly soils for digging dens; favors creosote and cactus scrub habitats with high densities of annual blooms in spring for feeding |
| Barefoot gecko *Coleonyx switaki (=Anarbylus s.)* | SC/T | Six known populations in California, all in San Diego and Imperial Counties; may also be undiscovered populations in Riverside County | Various types of rock outcroppings; active only from May through September |
| Coachella Valley fringe-toed lizard *Uma inornata* | T/E | Coachella Valley sand dunes in Riverside County | Sparse desert scrub and alkali desert scrub, which has fine, loose, wind-blown sand |
| Blunt-nosed leopard lizard *Gambelia (=Crotaphytus) silus* | E/E | San Joaquin Valley from Stanislaus County through Kern County and along the eastern edges of San Luis Obispo and San Benito Counties | Open habitats with scattered low bushes on alkali flats, and low foothills, canyon floors, plains, washes, and arroyos; substrates may range from sandy or gravelly soils to hardpan |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Flat-tailed horned lizard *Phrynosoma mcallii* | --/SSC, FP | Populations in Imperial, San Diego, and Riverside Counties | Sandy areas, desert pavement, and locations with soils; shares the same wind-blown, fine-sand habitat as the fringe-toed lizard |
| Island night lizard *Xantusia riversiana* | T/SSC | Channel Islands (i.e., Santa Barbara, Sutil, San Clemente, and San Nicolas Islands) | Rock outcroppings and shrub cover |
| Southern rubber boa *Charina bottae umbratica* | SC/T | Fragmented populations occur in La Panza Range, San Luis Obispo County; San Gabriel Mountains, Los Angeles County; and the Tehachapi Mountains, Kern County | Moist coniferous forests and montane hardwood habitats with suitable escape cover, including rocks, logs, and leaf litter |
| Alameda whipsnake *Masticophis lateralis euryxanthus* | T/T | Restricted to Alameda and Contra Costa Counties | Valleys, foothills, and low mountains associated with northern coastal scrub or chaparral habitat; requires rock outcrops for cover and foraging |
| San Francisco garter snake *Thamnophis sirtalis tetrataenia* | E/E | Northern San Mateo County southward along the coast and the eastern slope of the Santa Cruz Mountains to the Santa Clara County line | Favors ponds, lakes, and marshy areas containing abundant vegetation, which it uses for cover |
| Giant garter snake *Thamnophis gigas* | T/T | Central Valley from Fresno north to the Gridley/Sutter Buttes area; has been extirpated from areas south of Fresno | Sloughs, canals, and other small waterways where there is a prey base of small fish and amphibians; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter |
| Brown pelican *Pelecanus occidentalis* | E/E | Present along the entire coastline, but does not breed north of Monterey County; extremely rare inland | Typically in littoral ocean zones, just outside the surf line; nests on offshore islands |
| California brown pelican (nesting colony) *Pelecanus occidentalis* | E/E | Present along the entire coastline, but does not breed north of Monterey County; extremely rare inland | Typically in littoral ocean zones, just outside the surf line; nests on offshore islands |
| Aleutian Canada goose *Branta canadensis leucopareia* | T/-- | The entire population winters in Butte Sink, then moves to Los Banos, Modesto, the Delta, and East Bay reservoirs; stages near Crescent City during spring before migrating to breeding grounds | Roosts in large marshes, flooded fields, stock ponds, and reservoirs; forages in pastures, meadows, and harvested grainfields; corn is especially preferred |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| California condor<br>*Gymnogyps californianus* | E/E | Historically, rugged mountain ranges surrounding the southern San Joaquin Valley; currently, most individuals are in captive populations, but a few birds were recently released in the rugged portions of the Los Padres National Forest | Requires large blocks of open savanna, grasslands, and foothill chaparral with large trees, cliffs, and snags for roosting and nesting |
| Bald eagle<br>*Haliaeetus leucocephalus* | T/E | Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin; reintroduced into central coast; winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierras, and east of the Sierra Nevada south of Mono County; range expanding | In western North America, nests and roosts in coniferous forests within 1 mile of a lake, a reservoir, a stream, or the ocean |
| Swainson's hawk<br>*Buteo swainsoni* | --/T | Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; the state's highest nesting densities occur near Davis and Woodland, Yolo County | Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, grain fields, and vegetable crops |
| American peregrine falcon<br>*Falco peregrinus anatum* (nesting) | E/E | Permanent resident on the north and south Coast Ranges; may summer on the Cascade and Klamath Ranges south through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range | Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large populations of other bird species |
| California clapper rail<br>*Rallus longirostris obsoletus* | E/E | Marshes around the San Francisco Bay and east to Suisun Marsh | Restricted to salt marshes and tidal sloughs; usually associated with heavy growth of pickleweed; feeds on mollusks removed from the mud in sloughs |
| Light-footed clapper rail<br>*Rallus longirostris levipes* | E/E | Small populations along the coast in Santa Barbara, Ventura, Orange, and San Diego Counties | Restricted to salt marshes and tidal sloughs where pickleweed is abundant |
| Black rail<br>*Laterallus jamaicensis* | SC/T | Permanent resident in the San Francisco Bay and eastward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties | Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Yuma clapper rail<br>*Rallus longirostris yumanensis* | E/E | Permanent resident in the Salton Sea and along the Colorado River in San Bernardino, Riverside, and Imperial Counties | Freshwater marshes and brackish marshes; requires regenerating marsh for foraging and mature cattail and bulrush for nesting |
| Greater sandhill crane<br>*Grus canadensis tabida* | --/T | Breeds on the plains east of the Cascade Range and south to Sierra County; winters in the Central Valley, southern Imperial County, Lake Havasu National Wildlife Refuge, and the Colorado River Indian Reserve | Summers in open terrain near shallow lakes or freshwater marshes; winters in plains and valleys near bodies of fresh water |
| Western snowy plover<br>*Charadrius alexandrinus nivosus* (coastal) | T/SSC | Winters along the coast from Del Norte County to San Diego County: breeding sites within this range are very limited | Coastal beaches above the normal high tide limit with wood or other debris for cover |
| California least tern<br>*Sterna antillarum (=albifrons) browni* | E/E | Nests on beaches along the San Francisco Bay and along the southern California coast from southern San Luis Obispo County south to San Diego County | Nests on sandy, upper ocean beaches, and occasionally uses mudflats; forages on adjacent surf line, estuaries, or the open ocean |
| Marbled murrelet<br>*Brachyramphus marmoratus* | T/E | Nesting sites from the Oregon border to Eureka and between Santa Cruz and Half Moon Bay; winters in nearshore and offshore waters along the entire California coastline | Mature, coastal coniferous forests for nesting; nearby coastal water for foraging; nests in conifer stands greater than 150 years old and may be found up to 35 miles inland; winters on subtidal and pelagic waters often well offshore |
| Western yellow-billed cuckoo<br>*Coccyzus americanus occidentalis* | --/E | Nests along the upper Sacramento, lower Feather, south fork of the Kern, Amargosa, Santa Ana, and Colorado Rivers | Wide, dense riparian forests with a thick understory of willows for nesting; sites with a dominant cottonwood overstory are preferred for foraging; may avoid valley oak riparian habitats where scrub jays are abundant |
| Elf owl<br>*Micrathene whitneyi* (nesting) | –/E | Rare spring and summer resident along the Lower Colorado River | Nests in desert riparian dominated by cottonwood, sycamore, willow, or mesquite; absent from riparian habitat dominated by saltcedar |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Northern spotted owl *Strix occidentalis caurina* | T/SSC | A permanent resident throughout its range; found in the north Coast, Klamath, and western Cascade Range from Del Norte County to Marin County | Dense old-growth forests dominated by conifers with topped trees or oaks available for nesting crevices |
| Great gray owl *Strix nebulosa* | --/E | Permanent resident of the Sierra Nevada in Warner Mountains south to the Yosemite area | Late successional coniferous forests bordering meadows |
| Gila woodpecker *Melanerpes uropygialis* | –/E | Resident of the Lower Colorado River and locally near Brawley, Imperial County | Frequents desert riparian habitats and desert washes; also found in orchards and urban parks with shade trees |
| Gilded flicker *Colapter chrysoides* | –/E | Breeds along the Lower Colorado River, the Mojave Desert, and the Owens Valley | Desert riparian areas, desert washes, and habitats with Joshua trees and saguaro cactus |
| Willow flycatcher *Empidonax traillii* | SC/E | Summer range includes a narrow strip along the eastern Sierra Nevada from Shasta County to Kern County, another strip along the western Sierra Nevada from El Dorado County to Madera County; widespread in migration | Riparian areas and large, wet meadows with abundant willows for breeding; usually found in riparian habitats during migration |
| Southwestern willow flycatcher *Empidonax traillii extimus* | E/E | Breeds in coastal southern California in the Los Angeles Basin, the San Bernardino/Riverside area, and San Diego County; no longer breeds along the Colorado River and is known to exist only in eight widely disjunct nesting populations | Densely vegetated riparian habitat with streamside associations of cottonwoods and willows |
| Bank swallow *Riparia riparia* | --/T | The state's largest remaining breeding populations are along the Sacramento River from Tehama County to Sacramento County and along the Feather and lower American Rivers and Cache Creek, in the Owens Valley; nesting areas also include the plains east of the Cascade Range south through Lassen County, northern Siskiyou County, and small populations near the coast from San Francisco County to Monterey County | Nests in bluffs or banks (usually steep), adjacent to water, where the soil consists of sand or sandy loam to allow digging |
| California gnatcatcher *Polioptila californica* | T/SSC | Found only along the southern California coast from Los Angeles County to San Diego County | Permanent resident in coastal sage scrub, where it prefers relatively dense stands dominated by California sage (*Artemesia californica*) |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| San Clemente loggerhead shrike *Lanius ludovicianus mearnsi* | E/-- | San Clemente Island | Prefers open habitats (washes, ravines, and mesas) with scattered shrubs, trees, posts, fences, or other perches |
| Least Bell's vireo *Vireo bellii pusillus* | E/E | Small populations remain in southern Inyo, southern San Bernardino, Riverside, San Diego, Orange, Los Angeles, Ventura, and Santa Barbara Counties | Riparian thickets either near water or in dry portions of river bottoms; nests along margins of bushes and forages low to the ground; may also be found using mesquite and arrow weed in desert canyons |
| San Clemente sage sparrow *Amphispiza belli clementeae* | T/-- | San Clemente Island and possibly San Nicolas and Santa Rosa Islands | Brushlands |
| Belding's savannah sparrow *Passerculus sandwichensis beldingi* | SC/E | Small, fragmented populations remain along the coast from Santa Barbara County to San Diego County | Tidal areas supporting pickleweed; may also use alkali sloughs on the coastal plains |
| Inyo California towhee *Pipilo crissalis cromophilus* | T/E | Restricted to a 95-square-mile area of the Mojave Desert west of Death Valley, Inyo County | Nests in dense stands of riparian vegetation, especially arroyo willow and desert olive; forages in sparsely vegetated desert scrub |
| Riparian brush rabbit *Sylvilagus bachmani riparius* | PE/E | Limited to San Joaquin County at Caswell State Park near the confluence of the Stanislaus and San Joaquin Rivers | Dense thickets of brush associated with riparian or chaparral habitats |
| Point Arena mountain beaver *Aplodontia rufa nigra* | E/SSC | Known only from Alder Creek in the Point Arena area of Mendocino County | North-facing, wooded slopes of ridges or gullies where there is abundant moisture, thick under growth, and soft soil for burrowing |
| Nelson's antelope ground squirrel *Ammospermophilus nelsoni* | SC/T | Western side of the San Joaquin Valley from southern Merced County south to Kern and Tulare Counties; also found on the Carrizo Plain in San Luis Obispo County and the Cuyama Valley in San Luis Obispo and Santa Barbara Counties | Arid grasslands from 200 to 1,200 feet, with loamy soils and moderate shrub cover of atriplex and other shrub species |
| Mohave ground squirrel *Spermophilus mohavensis* | SC/T | Southwestern Inyo County, eastern Kern County, northwestern San Bernardino County, and northeastern Los Angeles County | Saltbush, alkali desert, and creosote bush scrub at elevations from 1,800 to 5,000 feet |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Morro Bay kangaroo rat *Dipodomys heermanni morroensis* | E/E | Found only near Los Osos, San Luis Obispo County | Coastal scrub habitats on old sand dune soils |
| San Bernardino Merriam's kangaroo rat *Dipodomys merriami parvus* | E/SSC | Occurs from the San Bernardino Valley in San Bernardino County to the Menifee Valley in Riverside County | Occurs primarily on sandy loam substrates characteristic of alluvial fans and flood plains dominated by various types of coastal sage scrub and chaparral habitat in early to intermediate successional stages |
| Fresno kangaroo rat *Dipodomys nitratoides exilis* | E/E | Found only in Fresno County | Found at elevations from 200 to 300 feet in alkali sink habitats |
| Tipton kangaroo rat *Dipodomys nitratoides nitratoides* | E/E | Occurs in the Tulare Lake Basin in portions of Fresno, Tulare, and Kern Counties | Found at elevations from 200 to 300 feet in arid grassland and alkali desert scrub communities with sparsely scattered shrubs; soil is usually finely textured and alkaline; may use areas that flood in winter and spring |
| Stephens' kangaroo rat *Dipodomys stephensis* (incl. *D. cascus)* | E/T | Found in the San Jacinto Valley in western Riverside, southwestern San Bernardino, and northwestern San Diego Counties | Uses annual grasslands with sparse perennial vegetation |
| Giant kangaroo rat *Dipodomys ingens* | E/E | Occurs at high densities in only 12 square miles of habitat along the western side of the San Joaquin Valley, in five separate localities on Elkhorn Plain, Carrizo Plain, McKittrick Valley, and Cuyama Valley in Kern and San Luis Obispo Counties | Restricted to flat, sparsely vegetated areas with native annual grassland and shrubland habitats; requires uncultivated soils consisting of dry, fine, sandy loams for burrowing |
| Pacific pocket mouse *Perognathus longimembris pacificus* | E/SSC | Historically, inhabited the coastal plains from El Segundo in Los Angeles County south to the Mexico border; only one population is known from Los Angeles County | Open areas with dense scrub and very fine sandy soils |
| Salt marsh harvest mouse *Reithrodontomys raviventris* | E/E | San Francisco, San Pablo, and Suisun Bays | Salt marshes with a dense plant cover of pickleweed and fat hen; adjacent to an upland site |
| San Joaquin Valley woodrat *Neotoma fuscipes riparia* | PE/SSC | Caswell Memorial State Park, Stanislaus River | Riparian habitat |

| Common and Scientific Name | Status [a] Federal/State | California Distribution | Habitats |
|---|---|---|---|
| Amargosa vole<br>*Microtus californicus scirpensis* | E/E | Found only along the Amargosa River near Tecupa and Shoshone, Inyo County | Uses pockets of wetlands containing bulrushes, cattails, saltgrass, and willows |
| San Joaquin kit fox<br>*Vulpes macrotis mutica* | E/T | Principally occurs in the San Joaquin Valley and adjacent open foothills to the west; recent records from 17 counties extending from Kern County north to Contra Costa County | Saltbush scrub, grassland, oak, savanna, and freshwater scrub |
| Sierra Nevada red fox<br>*Vulpes vulpes necator* | SC/T | Cascade Range east to the Sierra Nevada then south to Tulare County | Red fir and lodgepole pine forests, generally from 5,000 to 8,400 feet, associated with mountain meadows |
| California wolverine<br>*Gulo gulo luteus* | SC/T | Klamath and Cascade Ranges south through the Sierra Nevada to Tulare County | Sighted in a variety of habitats from 1,600 to 14,200 feet; most common in open terrain above timberline and subalpine forests |
| Southern sea otter<br>*Enhydra lutris nereis* | T/FP | Central Coast from San Mateo County to Santa Barbara County | Nearshore marine environment |
| Guadalupe fur seal<br>*Arctocephalus townsendii* | T/T | Primarily Baja California, but occasionally on San Miguel Island and San Nicolas Island | Rocky insular shorelines and sheltered coves |
| Northern (Steller) sea lion<br>*Eumetopias jubatus* (rookery) | T/-- | Rookeries occur on Año Nuevo Island, Farallon Islands, Point Saint George, and Surgarloaf on Cape Mendocino | Rookeries occur on rocky, isolated islands and peninsulas; feeds in nearshore water |
| California bighorn sheep<br>*Ovis canadensis californiana* | SC/T | Southern Sierra Nevada | Shrublands, grasslands, and riparian habitats in rugged terrain |
| Peninsular bighorn sheep<br>*Ovis canadensis cremnobates* | PE/T | San Jacinto Mountains south of Palm Springs, Riverside County south to the Mexican border | Open areas in steep, rugged terrain with sparse vegetation with adequate water supply |

[a] Status definitions:

**Federal**

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PE = proposed for federal listing as endangered under the federal Endangered Species Act.
PT = proposed for federal listing as threatened under the federal Endangered Species Act.

SC = species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.
-- = no designations.

**State**

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
FP = fully protected under the California Fish and Game Code.
SSC = species of special concern in California.
-- = no designations.

# Appendix G. Background Information on Acoustics

# Appendix G. Background Information on Acoustics

## Sound Terminology

Sound travels through the air as waves of minute air pressure fluctuations caused by some type of vibration. In general, sound waves travel away from the sound source as an expanding spherical surface. The energy contained in a sound wave is consequently spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the sound source. The following terms are commonly used in acoustics.

### Decibel

Sound-level meters measure the pressure fluctuations caused by sound waves. Because of the ability of the human ear to respond to a wide dynamic range of sound pressure fluctuations, loudness is measured in terms of decibels (dB) on a logarithmic scale. This results in a scale that measures pressure fluctuations in a convenient notation and corresponds to our auditory perception of increasing loudness.

### A-Weighted Decibels

Most sounds consist of a broad range of sound frequencies. Because the human ear is not equally sensitive to all frequencies, several frequency-weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to sound levels. The “A-weighted” decibel scale (dBA) is the most widely used for this purpose. Typical A-weighted sound levels for various types of sound sources are summarized in Figure G-1.

| Sound Source | Sound Level (dBA)* | Response |
|---|---|---|
| Carrier deck jet operation | **140** | |
| Civil defense siren (at 100 feet) | **130** | Painfully loud |
| Jet takeoff (at 200 feet) | **120** | Threshold of feeling and pain |
| Riveting machine (at 1 foot)<br>Rock music concert | **110** | |
| Pile driver (at 50 feet)<br>Ambulance siren (at 100 feet) | **100** | Very loud |
| Heavy truck (at 50 feet) | **90** | |
| Pneumatic drill (at 50 feet)<br>Freight train cars (at 50 feet)<br>Garbage disposal in home | **80** | |
| Freight train cars (at 100 feet)<br>Freeway traffic (at 50 feet)<br>Vacuum cleaner (at 10 feet) | **70** | Moderately loud |
| Air conditioning unit (at 20 feet) | **60** | |
| Speech in normal voice (at 15 feet) | **50** | |
| Residence-typical movement of people, no TV or radio | **40** | Quiet |
| Soft whisper (at 5 feet) | **30** | |
| Recording studio | **20** | |
| | **10** | |
| | **0** | Threshold of hearing |

* Typical A-weighted sound levels in decibels. "A" weighting approximates the frequency response of the human ear.

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**Figure G-1**
**Weighted Sound Levels and Human Response**

## Equivalent Sound Level

Time-varying sound levels are often described in terms of an equivalent constant decibel level. Equivalent sound levels ($L_{eq}$) are used to develop single-value descriptions of average sound exposure over various periods of time. Such average sound exposure values often include additional weighting factors for annoyance potential attributable to time of day or other considerations. The $L_{eq}$ data used for these average sound exposure descriptors are generally based on A-weighted sound-level measurements.

## Day-Night Average Sound Level

Average sound exposure over a 24-hour period is often presented as a day-night average sound level ($L_{dn}$). $L_{dn}$ values are calculated from hourly $L_{eq}$ values, with the $L_{eq}$ values for the nighttime period (10:00 p.m.-7:00 a.m.) increased by 10 dB to reflect the greater disturbance potential from nighttime noises.

## Community Noise Equivalent Level

The community noise equivalent level (CNEL) is also used to characterize average sound levels over a 24-hour period, with weighting factors included for evening and nighttime sound levels. $L_{eq}$ values for the evening period (7:00 p.m.-10:00 p.m.) are increased by 5 dB, while $L_{eq}$ values for the nighttime period (10:00 p.m.-7:00 a.m.) are increased by 10 dB. For given set of sound measurements, the CNEL value will usually be about 1 dB higher than the $L_{dn}$ value. In practice, CNEL and $L_{dn}$ are often used interchangeably.

## Percentile-Exceeded, Maximum, and Minimum Sound Level

The sound level exceeded during a given percentage of a measurement period is the percentile-exceeded sound level ($L_x$). Examples include $L_{10}$, $L_{50}$, and $L_{90}$. $L_{10}$ is the A-weighted sound level that is exceeded 10% of the measurement period, $L_{50}$ is the level exceeded 50% of the period, and so on. $L_{50}$ is the median sound level measured during the measurement period. $L_{90,}$ the sound level exceeded 90% of the time, excludes high localized sound levels produced by nearby sources such as single car passages or bird chirps. $L_{90}$ is often used to represent the background sound level. $L_{50}$ is also used to provide a less conservative assessment of the background sound level.

The maximum sound level ($L_{max}$) and the minimum sound level ($L_{min}$) are the maximum and minimum sound levels respectively, measured during the measurement period. When a sound meter is set to the "slow" response setting as is typical for most community noise measurements, the Lmax and Lmin values are the maximum and minimum levels measured over a one second period.

### Ambient Sound

Ambient sound is the all-encompassing sound associated with a given community site, usually being a composite of sounds from many sources, near and far, with no particular sound being dominant.

## Equivalencies between Various Sound Descriptors

The $L_{dn}$ value at a site calculated from a set of measurements taken over a given 24-hour period will be slightly lower than the CNEL value calculated over the same period. Except in situations where unusually high evening sound levels occur, the CNEL value will be within 1.5 dB of the $L_{dn}$ value for the same set of sound measurements.

The relationship between peak hourly $L_{eq}$ values and associated $L_{dn}$ values depends on the distribution of traffic over the entire day. There is no precise way to convert a peak hourly $L_{eq}$ value to an $L_{dn}$ value. However, in urban areas near heavy traffic, the peak hourly $L_{eq}$ value is typically 2-4 dB lower than the daily $L_{dn}$ value. In less heavily developed areas, the peak hourly $L_{eq}$ is often equal to the daily $L_{dn}$ value. For rural areas with little nighttime traffic, the peak hourly $L_{eq}$ value will often be 3-4 dB greater than the daily $L_{dn}$ value.

## Working with Decibel Values

The nature of the decibel scale is such that the individual sound levels for different sound sources cannot be added directly to give the combined sound level of these sources. Two sound sources producing equal sound levels at a given location will produce a composite sound level that is 3 dB greater than either sound alone. When two sound sources differ by 10 dB, the composite sound level will be only 0.4 dB greater than the louder source alone.

Most people have difficulty distinguishing the louder of two sound sources if they differ by less than 1.5-2.0 dB. Research into the human perception of changes in sound level indicates the following:

- a 3-dB change is just perceptible,
- a 5-dB change is clearly perceptible, and
- a 10-dB change is perceived as being twice or half as loud.

A doubling or halving of acoustic energy will change the resulting sound level by 3 dB, which corresponds to a change that is just perceptible. In practice, this means that a doubling of traffic volume on a roadway, doubling the number of people in a stadium, or doubling the number of wind turbines in a wind farm will, as a general rule, only result in a 3-dB, or just perceptible, increase in noise.

# Outdoor Sound Propagation

There are a number of factors that affect how sound propagates outdoors. These factors, described by Hoover and Keith (1996), are summarized below.

## Distance Attenuation

As a general rule, sound from localized or point sound sources spreads out as it travels away from the source and the sound level drops at a rate of 6 dB per doubling of distance. If the sound source is long in one dimension, such as traffic on a highway or a long train, the sound source is considered to be a line source. As a general rule, the sound level from a line source will drop off at a rate of 3 dB per doubling of distance. If the intervening ground between the line source and the receptor is acoustically “soft” (e.g., ground vegetation, scattered trees, clumps of bushes), an attenuation rate of 4.5 dB per doubling of distance is generally used.

## Attenuation from Barriers

Any solid structure such as a berm, wall, or building that blocks the line of sight between a source and receiver serves as a sound barrier and will result in additional sound attenuation. The amount of additional attenuation is a function of the difference between the length of the sound path over the barrier and the length of the direct line of sight path. Thus, the sound attenuation of a barrier between a source and a receiver that are very

far apart will be much less than the attenuation that would result if either the source or the receiver is very close to the barrier.

### Molecular Absorption

Air absorbs sound energy as a function of the temperature, humidity of the air, and frequency of the sound. Additional sound attenuation on the order of 1 to 2 dB per 1,000 feet can occur.

### Anomalous Excess Attenuation

Large-scale effects of wind speed, wind direction, and thermal gradients in the air can cause large differences in sound transmission over large distances. These effects when combined result in anomalous excess attenuation, which can be applied to long-term sound-level estimates. Additional sound attenuation on the order of about 1 dB per 1,000 feet can occur.

### Other Atmospheric Effects

Short-term atmospheric effects relating to wind and temperature gradients can cause bending of sound waves and can influence changes in sound levels at large distances. These effects can either increase or decrease sound levels depending on the orientation of the source and receptor and the nature of the wind and temperature gradient. Because these effects are normally short-term, it is generally not practical to include them in sound propagation calculations. Understanding these effects, however, can help explain variations that occur between calculated and measured sound levels.

## Guidelines for Interpreting Sound Levels

Various federal, state, and local agencies have developed guidelines for evaluating land use compatibility under different sound-level ranges. The following is a summary of federal and state guidelines.

## Federal Agency Guidelines

The federal Noise Control Act of 1972 (Public Law 92-574) established a requirement that all federal agencies administer their programs to promote an environment free of noise that jeopardizes public health or welfare. The U.S. Environmental Protection Agency (EPA) was given the responsibility for:

- providing information to the public regarding identifiable effects of noise on public health or welfare,
- publishing information on the levels of environmental noise that will protect the public health and welfare with an adequate margin of safety,
- coordinating federal research and activities related to noise control, and
- establishing federal noise emission standards for selected products distributed in interstate commerce.

The federal Noise Control Act also directed that all federal agencies comply with applicable federal, state, interstate, and local noise control regulations.

Although EPA was given major public information and federal agency coordination roles, each federal agency retains authority to adopt noise regulations pertaining to agency programs. EPA can require other federal agencies to justify their noise regulations in terms of the federal Noise Control Act policy requirements. The Occupational Safety and Health Administration retains primary authority for setting workplace noise exposure standards. The Federal Aviation Administration retains primary jurisdiction over aircraft noise standards, and the Federal Highway Administration (FHWA) retains primary jurisdiction over highway noise standards.

In 1974, in response to the requirements of the federal Noise Control Act, EPA identified indoor and outdoor noise limits to protect public health and welfare (communication disruption, sleep disturbance, and hearing damage). Outdoor $L_{dn}$ limits of 55 dB and indoor $L_{dn}$ limits of 45 dB are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Sound-level criteria to protect against hearing damage in commercial and industrial areas are identified as 24-hour $L_{eq}$ values of 70 dB (both outdoors and indoors).

The FHWA has adopted criteria for evaluating noise impacts associated with federally funded highway projects and for determining whether these impacts are sufficient to justify funding noise mitigation actions (23 CFR 772). The FHWA noise abatement criteria are based on peak hourly $L_{eq}$ sound levels, not $L_{dn}$ or 24-hour $L_{eq}$ values. The

peak 1-hour $L_{eq}$ criteria for residential, educational, and healthcare facilities are 67 dB outdoors and 52 dB indoors. The peak 1-hour $L_{eq}$ criterion for commercial and industrial areas is 72 dB (outdoors).

The U.S. Department of Housing and Urban Development has established guidelines for evaluating noise impacts on residential projects seeking financial support under various grant programs (44 FR 135:40860-40866, January 23, 1979). Sites are generally considered acceptable for residential use if they are exposed to outdoor $L_{dn}$ values of 65 dB or less. Sites are considered "normally unacceptable" if they are exposed to outdoor $L_{dn}$ values of 65-75 dB. Sites are considered unacceptable if they are exposed to outdoor $L_{dn}$ values above 75 dB.

## State Agency Guidelines

In 1987, the California Department of Health Services published guidelines for the noise elements of local general plans. These guidelines include a sound level/land use compatibility chart that categorizes various outdoor $L_{dn}$ ranges into up to four compatibility categories (normally acceptable, conditionally acceptable, normally unacceptable, and clearly unacceptable) by land use. For many land uses, the chart shows overlapping $L_{dn}$ ranges for two or more compatibility categories.

The noise element guidelines chart identifies the normally acceptable range for low-density residential uses as less than 60 dB and the conditionally acceptable range as 55-70 dB. The normally acceptable range for high-density residential uses is identified as $L_{dn}$ values below 65 dB, and the conditionally acceptable range is identified as 60-70 dB. For educational and medical facilities, $L_{dn}$ values below 70 dB are considered normally acceptable and $L_{dn}$ values of 60-70 dB are considered conditionally acceptable. For office and commercial land uses, $L_{dn}$ values below 70 dB are considered normally acceptable and $L_{dn}$ values of 67.5-77.5 are categorized as conditionally acceptable.

These overlapping $L_{dn}$ ranges are intended to indicate that local conditions (existing sound levels and community attitudes toward dominant sound sources) should be considered in evaluating land use compatibility at specific locations.

The California Department of Housing and Community Development has adopted noise insulation performance standards for new hotels, motels, and dwellings other than detached single-family structures (24 CCR T25-28). These standards require that "interior CNELs with windows closed, attributable to exterior sources, shall not exceed an annual CNEL of 45 dB in any habitable room".

The California Department of Transportation uses the FHWA criteria as the basis for evaluating noise impacts from highway projects.

## Reference

Hoover, R. M., and R. H. Keith. 1996. Noise control for buildings and manufacturing plants. Hoover and Keith, Inc. Houston, TX.

# Appendix H. Land Application of Biosolids – Excerpt from the U.S. EPA's *A Plain English Guide to the EPA Part 503 Biosolids* Rule

EPA/832/R-93/003
September 1994

# A Plain English Guide to the EPA Part 503 Biosolids Rule

U.S. Environmental Protection Agency
Office of Wastewater Management
Washington, DC

# Chapter 2

# Land Application of Biosolids

## What Is Land Application?

Land application is the application of biosolids to land to either condition the soil or to fertilize crops or other vegetation grown in the soil. Nearly half of the biosolids production in the United States is currently being used beneficially to improve soils. This guidance document categorizes the types of land that benefit from the application of biosolids (see Figure 2-1) as follows:

- agricultural land, forests, and reclamation sites—collectively called ***nonpublic contact sites*** (areas not frequently visited by the public); and
- public parks, plant nurseries, roadsides, golf courses, lawns, and home gardens—collectively called ***public contact sites*** (areas where people are likely to come into contact with biosolids applied to land). The Part 503 rule, however, does not regard lawns and home gardens as public contact sites, and fewer types of biosolids may be land applied to these sites (i.e., CPLR biosolids are not permitted on lawns and home gardens given the considerable difficulty of tracking cumulative levels of metals in biosolids applied to such sites).

Biosolids can be either applied to land in ***bulk*** or sold or given away in ***bags or other containers*** for land application (see Figure 2-2). The term ***biosolids in bulk*** refers to biosolids that are marketed or given to manufacturers of products that contain biosolids. The term ***biosolids in bags*** generally refers to biosolids in amounts that are bagged and generally marketed for use on smaller units of land such as lawns and home gardens.

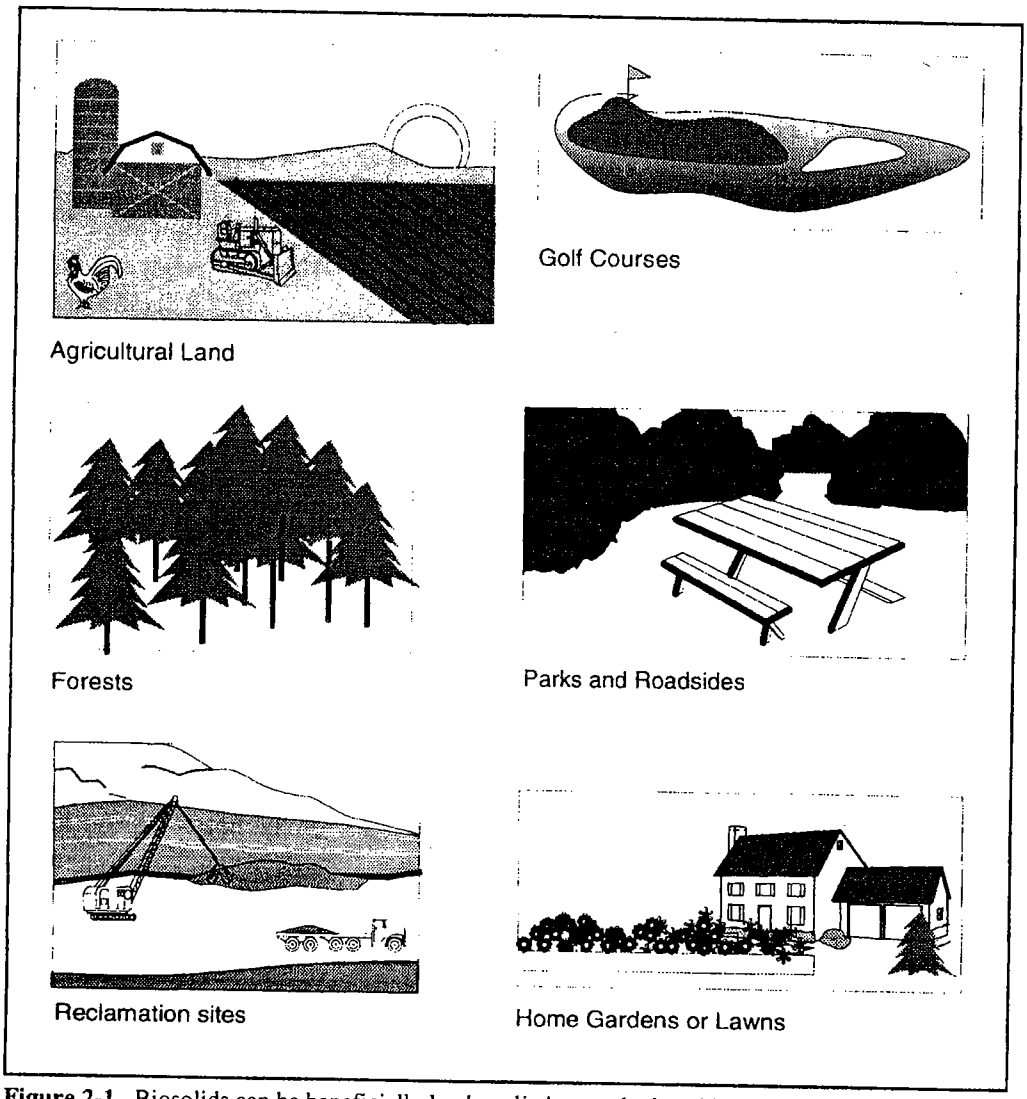



**Figure 2-1.** Biosolids can be beneficially land applied on agricultural land, forest land, reclamation sites, golf courses, public parks, roadsides, plant nurseries, and lawns and home gardens.

The term ***other containers*** is defined in the Part 503 rule as open or closed receptacles (e.g., buckets, boxes, or cartons) or vehicles with a load capacity of one metric ton or less. (Most pickup trucks as well as trailers pulled by an automobile would meet the regulatory definition of other containers.)

Biosolids are generally land applied using one of several techniques. The biosolids may be sprayed or spread on the soil surface and left on the surface (e.g., on pastures, range and forest land, or lawn). They also may be tilled (incorporated) into the soil after being surface applied or injected

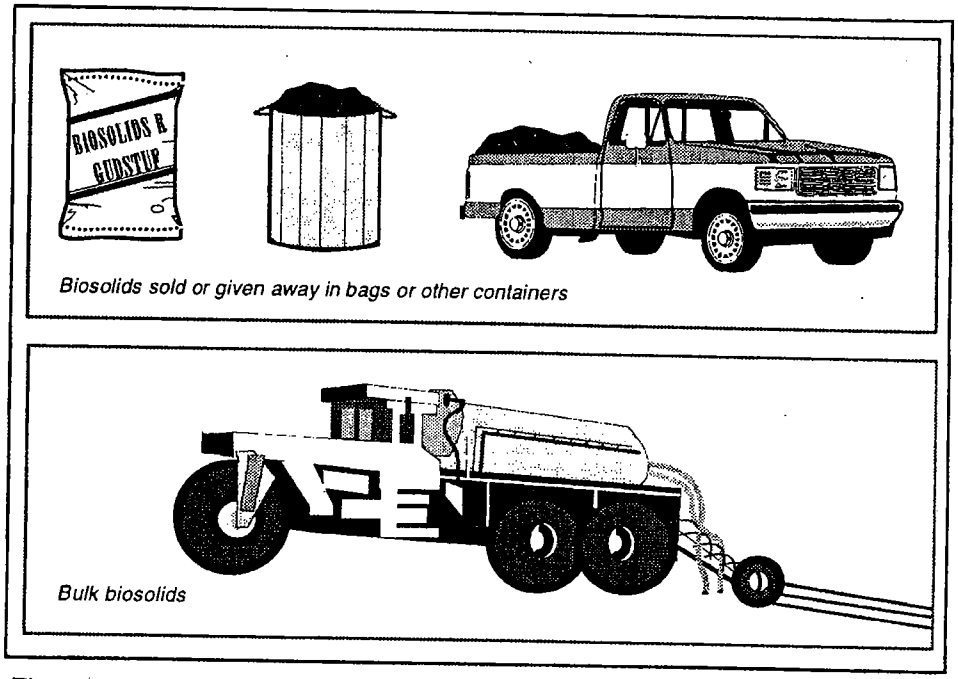



**Figure 2-2.** For application to the land, biosolids can be sold or given away in bags, in other containers, or they can be land applied in bulk form.

directly below the surface for producing row crops or other vegetation and for establishing lawns.

Biosolids in a liquid state can be applied using tractors, tank wagons, irrigation systems, or special application vehicles. Dewatered biosolids are typically applied to land using equipment similar to that used for applying limestone, animal manures, or commercial fertilizers. Both liquid and dewatered biosolids are applied to land with or without subsequent incorporation into the soil.

Because biosolids are typically treated before being land applied, their use poses a low degree of risk. This chapter discusses approaches for meeting the requirements of the Part 503 rule for the land application of biosolids.

The practice of growing crops or grazing animals on a biosolids surface disposal site, another form of beneficial use, is discussed in Chapter 3. This guidance document refers to this practice as ***dedicated beneficial use***. A permitting authority can allow crops to be grown on a surface disposal site and marketed or grazed if the owner/operator of the site shows that site-specific management practices are being used that will ensure protection of public health and the environment from any reasonably anticipated adverse effects of certain pollutants that can be present in biosolids.

*Spreading finished biosolids product on Walt Disney World tree farm in Orlando, Florida.*

## To Whom the Land Application Requirements Apply

Different provisions of the Part 503 rule apply to the ***preparer*** and the ***applier*** of biosolids. The ***preparer*** of biosolids is defined as a person who either ***generates*** biosolids during the treatment of domestic sewage in a treatment works or who ***derives*** a material from biosolids (i.e., changes the quality of the biosolids prepared by a generator). Examples of materials derived from biosolids include biosolids treated by composting, pelletizing, or drying (to kill pathogens and reduce attractiveness to vectors), and mixtures of biosolids with other materials (e.g., biosolids blended with soil or fertilizer, which will usually lower pollutant concentrations). The ***applier*** is defined as the person who applies the biosolids to land. The responsibilities of preparers and appliers of biosolids under the Part 503 rule are summarized in Figure 2-8.

Landowners and leaseholders also have certain responsibilities. These are discussed at the end of this chapter.

## Land Application Requirements

Biosolids applied to the land must meet risk-based pollutant limits specified in Part 503. Operational standards to control disease-causing organisms called pathogens and to reduce the attraction of vectors (e.g., flies, mosquitoes, and other potential disease-carrying organisms) to the

biosolids must also be met. In addition, there are general requirements, management practices, and frequency of monitoring, recordkeeping, and reporting requirements that must be met. Each of these land application requirements is discussed below.

## Pollutant Limits, Pathogen and Vector Attraction Reduction Requirements

All biosolids applied to the land must meet ***the ceiling concentrations for pollutants,*** listed in the first column of Table 2-1. The ceiling concentrations are the maximum concentration limits for ~~10~~ 9 heavy metal

**TABLE 2-1**
**Pollutant Limits**

| Pollutant | Ceiling Concentration Limits for All Biosolids Applied to Land (milligrams per kilogram)[a] | Pollutant Concentration Limits for EQ and PC Biosolids (milligrams per kilogram)[a] | Cumulative Pollutant Loading Rate Limits for CPLR Biosolids (kilograms per hectare) | Annual Pollutant Loading Rate Limits for APLR Biosolids (kilograms per hectare per 365-day period) |
|---|---|---|---|---|
| Arsenic | 75 | 41 | 41 | 2.0 |
| Cadmium | 85 | 39 | 39 | 1.9 |
| Chromium | 3,000 | 1,200 | 3,000 | 150 |
| Copper | 4,300 | 1,500 | 1,500 | 75 |
| Lead | 840 | 300 | 300 | 15 |
| Mercury | 57 | 17 | 17 | 0.85 |
| Molybdenum[b] | 75 | — | — | — |
| Nickel | 420 | 420 | 420 | 21 |
| Selenium | 100 | 36 | 100 | 5.0 |
| Zinc | 7,500 | 2,800 | 2,800 | 140 |
| Applies to: | All biosolids that are land applied | Bulk biosolids and bagged biosolids[c] | Bulk biosolids | Bagged biosolids[c] |
| From Part 503 | Table 1, Section 503.13 | Table 3, Section 503.13 | Table 2, Section 503.13 | Table 4, Section 503.13 |

[a] Dry-weight basis

[b] As a result of the February 25, 1994, Amendment to the rule, the limits for molybdenum were deleted from the Part 503 rule pending EPA reconsideration.

[c] Bagged biosolids are sold or given away in a bag or other container.

40 CFR 503.13

pollutants in biosolids; specifically, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. If a limit for any one of the pollutants is exceeded, the biosolids cannot be applied to the land until such time that the ceiling concentration limits are no longer exceeded. The ceiling concentrations for pollutants are included in Part 503 to prevent the land application of biosolids with the highest levels of pollutants and to encourage pretreatment efforts that will result in lower levels of pollutants.

2 Biosolids applied to the land must also meet either pollutant concentration limits, cumulative pollutant loading rate limits, or annual pollutant loading rate limits for these same heavy metals.

3 Either ***Class A or Class B pathogen requirements*** (summarized in Table 2-5) ***and site restrictions*** (Figure 2-4) must be met before the biosolids can be land applied; the two classes differ depending on the level of pathogen reduction that has been obtained.

4 Finally, 1 of 10 options specified in Part 503 and summarized in Table 2-6 to achieve ***vector attraction reduction*** must be met when biosolids are applied to the land.

## Options for Meeting Land Application Requirements

This guidance document groups the Part 503 requirements into four options for meeting pollutant limits and pathogen and vector attraction reduction operational standards when biosolids are applied to the land. The options include:

- the Exceptional Quality (EQ) Option
- the Pollutant Concentration (PC) Option
- the Cumulative Pollutant Loading Rate (CPLR) Option
- the Annual Pollutant Loading Rate (APLR) Option

It is very important to realize that each option is equally protective of public health and the environment; that is, EQ, PC, CPLR, and APLR biosolids used in accordance with the Part 503 rule are equally safe. This safety is ensured by the combination of pollutant limits and management practices imposed by each option.

Whichever option is chosen, at a minimum, the ceiling concentrations for pollutants (listed in Table 2-1) and the frequency of monitoring, reporting, and recordkeeping requirements (see Tables 2-7 and 2-8) must be met. The four options are summarized in Table 2-2, illustrated in Figure 2-3, and discussed in detail below.

Depending on the land application option under consideration, site restrictions (Figure 2-4), general requirements (Figure 2-8), and management practices (Figure 2-9) also apply. These additional restrictions,

## TABLE 2-2
## Options for Meeting Pollutant Limits and Pathogen and Vector Attraction Reduction Requirements for Land Application

| Option* | Pollutant Limits | Pathogen Requirements | Vector Attraction Reduction Requirements |
|---|---|---|---|
| "Exceptional Quality" (EQ) Biosolids | Bulk or bagged biosolids meet pollutant concentration limits in Table 2-1 | Any 1 of the Class A requirements in Table 2-5 | Any 1 of the requirements in options 1 through 8 in Table 2-6 |
| "Pollutant Concentration" (PC) Biosolids | Bulk biosolids meet pollutant concentration limits in Table 2-1 | Any 1 of the Class B requirements in Table 2-5 and Figure 2-4 | Any 1 of the 10 requirements in Table 2-6 |
| | | Any 1 of the Class A requirements in Table 2-5 | Requirements 9 or 10 in Table 2-6 |
| "Cumulative Pollutant Loading Rate" (CPLR) Biosolids | Bulk biosolids applied subject to cumulative pollutant loading rate (CPLR) limits in Table 2-1 | Any 1 of the Class A or Class B requirements in Table 2-5 and Figure 2-4 | Any 1 of the 10 requirements in Table 2-6 |
| "Annual Pollutant Loading Rate" (APLR) Biosolids | Bagged biosolids applied subject to annual pollutant loading rate (APLR) limits in Table 2-1 | Any 1 of the Class A requirements in Table 2-5 | Any 1 of the first 8 requirements in Table 2-6 |

* Each of these options also requires that the biosolids meet the ceiling concentrations for pollutants listed in Table 2-1, and that the frequency of monitoring requirements in Table 2-7 and recordkeeping and reporting requirements in Table 2-8 be met. In addition, the general requirements in Figure 2-8 and the management practices in Figure 2-9 have to be met when biosolids are land applied (except for EQ biosolids).

requirements, and practices are summarized in Tables 2-3 and 2-4 and discussed in greater detail at the end of this chapter.

Rather than presenting the four options in the order described in the Part 503 rule, this document presents them in order of increasing regulatory requirements. Table 2-3 graphically displays the level of required regulatory control for each option. The types of land onto which these different biosolids may be applied are listed in Table 2-4.

### Option 1: Exceptional Quality (EQ) Biosolids

For biosolids to qualify under the EQ option, the following requirements must be met:

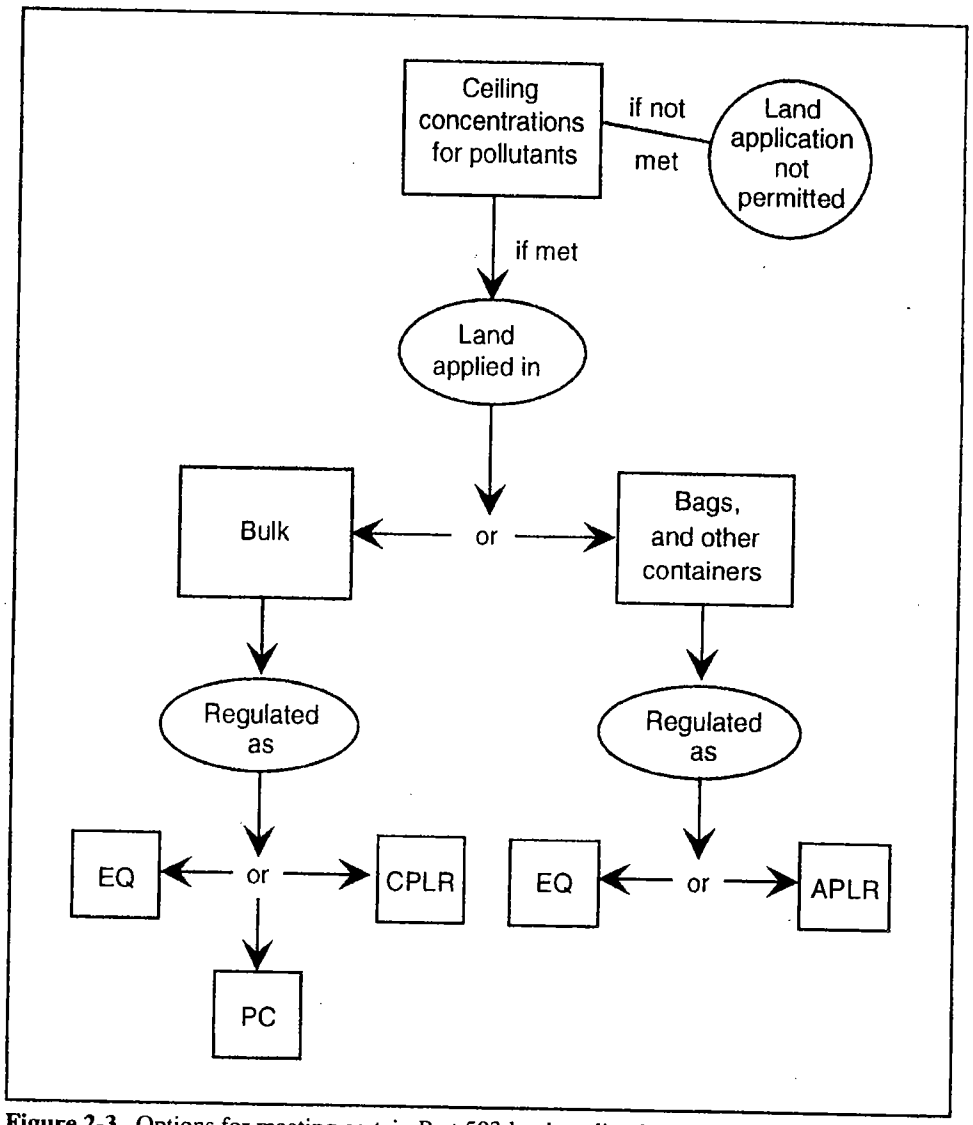



**Figure 2-3.** Options for meeting certain Part 503 land application requirements

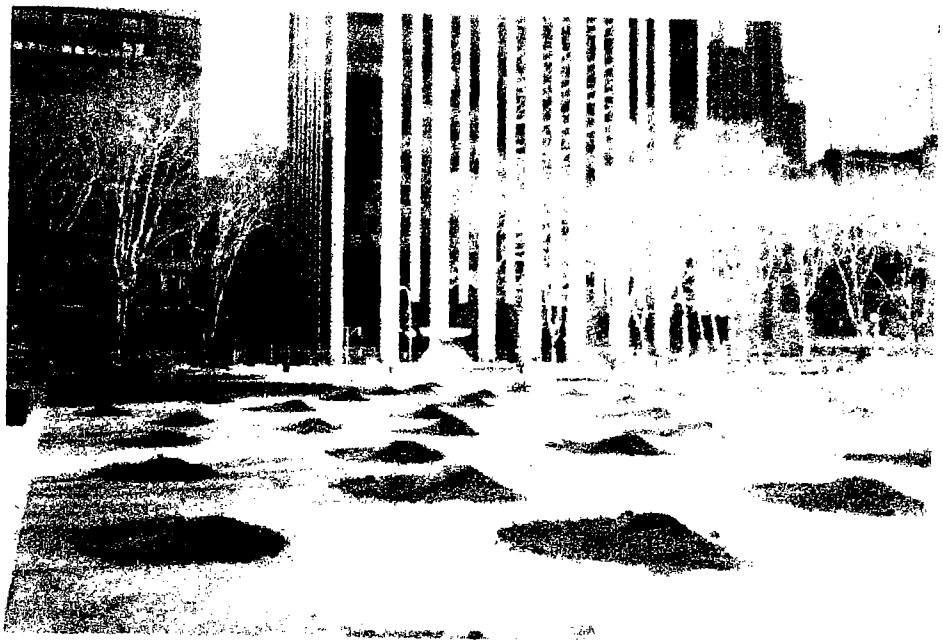
The ceiling concentrations for pollutants in Table 2-1 may not be exceeded.

The pollutant concentration limits in Table 2-1 may not be exceeded.

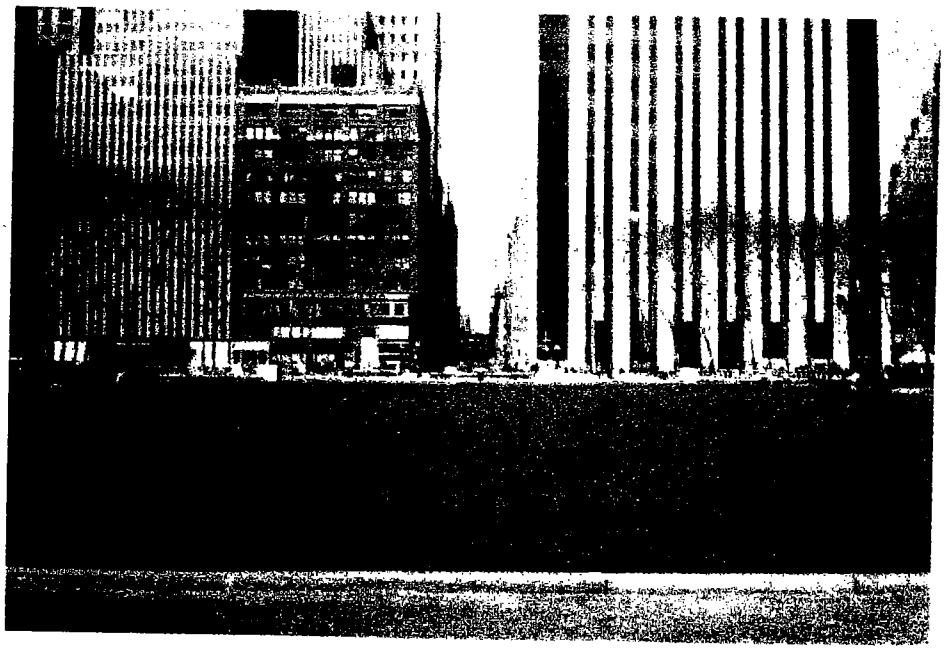
One of the Class A pathogen requirements in Table 2-5 must be met.

One of the first eight vector attraction reduction options in Table 2-6 must be achieved.

Methods that typically achieve the pathogen and vector attraction reduction requirements and allow biosolids to meet EQ requirements include alkaline stabilization, composting, and heat drying. The Part 503 frequency of



***Use of biosolids on parkland in Manhattan, New York.*** *Biosolids compost is piled on barren site to be spread for soil conditioning.*



***Use of biosolids on parkland in Manhattan, New York (continued).*** *One month after spreading of biosolids, the turf is vigorously established.*

*Use of biosolids on parkland in Manhattan, New York (continued). Different view showing public enjoying the park.*

monitoring, recordkeeping, and reporting requirements (see Tables 2-7 and 2-8) also must be met for EQ biosolids.

Once biosolids meet EQ requirements, they are not subject to the land application general requirements and management practices in Part 503, with one possible exception—if the Regional Administrator or the State Director determines, on a case-by-case basis, that such requirements are necessary to protect public health and the environment (this exception applies only to bulk biosolids). Once biosolids have been established as meeting EQ requirements, whether in bulk form or in bags or other containers, they can generally be applied as freely as any other fertilizer or soil amendment to any type of land. While not required by the Part 503 rule, EQ biosolids should be applied at a rate that does not exceed the agronomic rate that supplies the nitrogen needs of the plants being grown, just as for any other commercial fertilizer or soil amending material that contains nitrogen.

### Option 2: Pollutant Concentration (PC) Biosolids

To qualify under the PC option, biosolids must meet several requirements, including:

> The ceiling concentration for pollutants in Table 2-1 may not be exceeded.

## TABLE 2-3
## Summary of Regulatory Requirements for Different Types of Biosolids

| Type of Biosolids and Class of Pathogens | Meet Ceiling Concentration for Pollutants | Meet Pollutant Concentration Limits | Site Restrictions | General Requirements and Management Practices | Track Added Pollutants |
|---|---|---|---|---|---|
| EQ Bag or Bulk Class A | Yes | Yes | No | | |
| PC Bulk Only Class A[a] | Yes | Yes | No | Yes | No |
| PC Bulk Only Class B | Yes | Yes | Yes | | No |
| CPLR Bulk Only Class A | Yes | No | No | Yes | |
| CPLR Bulk Only Class B | Yes | No | Yes | | |
| APLR Bag Only Class A | Yes | No | No | Yes[b] | Yes[c] |

[a] Biosolids meeting Class A pathogen reduction requirements but following options 9 or 10 vector attraction reduction requirements are also considered PC biosolids.

[b] The only general and management practice requirement that must be met is a labeling requirement.

[c] The amount of biosolids that can be applied to a site during the year must be consistent with the annual whole sludge application rate (AWSAR) for the biosolids that does not cause any of the ALPRs to be exceeded.

Note: See Chapter Two text for explanation of biosolids types.

The pollutant concentration limits in Table 2-1 may not be exceeded (same requirement as for EQ biosolids, discussed above).

One of three Class B pathogen requirements must be met (see Table 2-5), as well as Class B site restrictions (see Figures 2-4 and 2-5).

One of 10 vector attraction reduction options must be achieved (see Table 2-6).

Frequency of monitoring (see Table 2-7), as well as recordkeeping and reporting requirements (see Table 2-8) must be met.

## TABLE 2-4
## Types of Land onto Which Different Types of Biosolids May Be Applied

| Biosolids Option | Pathogen Class | VAR[a] Options | Type of Land | Other Restrictions |
|---|---|---|---|---|
| EQ | A | 1-8 | All[b] | None |
| PC | A | 9 or 10 | All except lawn and home gardens[c] | Management practices |
| | B | 1-10 | All except lawn and home gardens[c] | Management practices and site restrictions |
| CPLR | A | 1-10 | All except lawn and home garden[d] | Management practices |
| | B | 1-10 | All except lawn and home garden[c,d] | Management practices and site restrictions |
| APLR | A | 1-8 | All, but most likely lawns and home gardens | Labeling management practice |

[a] VAR means vector attraction reduction.

[b] Agricultural land, forest, reclamation sites, and lawns and home gardens.

[c] It is not possible to impose site restrictions on lawns and home gardens.

[d] It is not possible to track cumulative additions of pollutants on lawns and home gardens.

Applicable site restrictions, general requirements, and management practices must be met (summarized in Tables 2-3 and 2-4 and listed in Figures 2-4, 2-8, and 2-9).

Class A biosolids meeting vector attraction reduction requirements 9 and 10 in Table 2-6 are another type of biosolids material that would fit in the PC category.

Thus, PC biosolids must meet more requirements than EQ biosolids, but are subject to fewer requirements than CPLR biosolids. Currently, the majority of biosolids in the United States could be characterized as PC biosolids, as defined in this guidance document.

### Option 3: Cumulative Pollutant Loading Rate (CPLR) Biosolids

The third option for meeting land application requirements allows bulk biosolids that do not meet the pollutant concentration limits in Table 2-1 to

## TABLE 2-5
## Summary of Class A and Class B Pathogen Reduction Requirements

**CLASS A**

In addition to meeting the requirements in one of the six alternatives listed below, fecal coliform or *Salmonella* sp. bacteria levels must meet specific density requirements at the time of biosolids use or disposal or when prepared for sale or give-away (see Chapter Five of this guidance)

***Alternative 1: Thermally Treated Biosolids***

Use one of four time-temperature regimens

***Alternative 2: Biosolids Treated in a High pH-High Temperature Process***

Specifies pH, temperature, and air-drying requirements

***Alternative 3: For Biosolids Treated in Other Processes***

Demonstrate that the process can reduce enteric viruses and viable helminth ova. Maintain operating conditions used in the demonstration

***Alternative 4: Biosolids Treated in Unknown Processes***

Demonstration of the process is unnecessary. Instead, test for pathogens—*Salmonella* sp. or fecal coliform bacteria, enteric viruses, and viable helminth ova—at the time the biosolids are used or disposed of or are prepared for sale or give-away

***Alternative 5: Use of PFRP***

Biosolids are treated in one of the Processes to Further Reduce Pathogens (PFRP) (see Table 5-4)

***Alternative 6: Use of a Process Equivalent to PFRP***

Biosolids are treated in a process equivalent to one of the PFRPs, as determined by the permitting authority

**CLASS B**

The requirements in one of the three alternatives below must be met

***Alternative 1: Monitoring of Indicator Organisms***

Test for fecal coliform density as an indicator for all pathogens at the time of biosolids use or disposal

***Alternative 2: Use of PSRP***

Biosolids are treated in one of the Processes to Significantly Reduce Pathogens (PSRP) (see Table 5-7)

***Alternative 3: Use of Processes Equivalent to PSRP***

Biosolids are treated in a process equivalent to one of the PSRPs, as determined by the permitting authority

40 CFR 503.32

Note: Details of each alternative for meeting the requirements for Class A and Class B designations are provided in Chapter Five.

## TABLE 2-6
## Summary of Vector Attraction Reduction Options

**Requirements in one of the following options must be met:**

| | |
|---|---|
| *Option 1:* | Reduce the mass of volatile solids by a minimum of 38 percent |
| *Option 2:* | Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit |
| *Option 3:* | Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit |
| *Option 4:* | Meet a specific oxygen uptake rate for aerobically treated biosolids |
| *Option 5:* | Use aerobic processes at greater than 40°C (average temperatures 45°C) for 14 days or longer (e.g., during biosolids composting) |
| *Option 6:* | Add alkaline materials to raise the pH under specified conditions |
| *Option 7:* | Reduce moisture content of biosolids that do not contain unstabilized solids from other than primary treatment to at least 75 percent solids |
| *Option 8:* | Reduce moisture content of biosolids with unstabilized solids to at least 90 percent |
| *Option 9:* | Inject biosolids beneath the soil surface within a specified time, depending on the level of pathogen treatment |
| *Option 10:* | Incorporate biosolids applied to or placed on the land surface within specified time periods after application to or placement on the land surface. |

40 CFR 503.33

Note: Details of each vector attraction reduction option are provided in Chapter Five.

## FIGURE 2-4
## Restrictions for the Harvesting of Crops and Turf, Grazing of Animals, and Public Access on Sites Where Class B Biosolids Are Applied

***Restrictions for the harvesting of crops* and turf:***

1. Food crops, feed crops, and fiber crops, whose edible parts do not touch the surface of the soil, shall not be harvested until *30 days* after biosolids application.
2. Food crops with harvested parts that touch the biosolids/soil mixture and are totally above ground shall not be harvested until *14 months* after application of biosolids.
3. Food crops with harvested parts below the land surface where biosolids remain on the land surface for 4 months or longer prior to incorporation into the soil shall not be harvested until *20 months* after biosolids application.
4. Food crops with harvested parts below the land surface where biosolids remain on the land surface for less than 4 months prior to incorporation shall not be harvested until *38 months* after biosolids application.
5. Turf grown on land where biosolids are applied shall not be harvested until *1 year* after application of the biosolids when the harvested turf is placed on either land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.

***Restriction for the grazing of animals:***

1. Animals shall not be grazed on land until *30 days* after application of biosolids to the land.

***Restrictions for public contact:***

1. Access to land with a high potential for public exposure, such as a park or ballfield, is restricted for *1 year* after biosolids application. Examples of restricted access include posting with no trespassing signs, and fencing.
2. Access to land with a low potential for public exposure (e.g., private farmland) is restricted for *30 days* after biosolids application. An example of restricted access is remoteness.

40 CFR 503.32(b)(5)

* Examples of crops impacted by Class B pathogen requirements are listed in Figure 2-5.

be land applied as safely as EQ and PC biosolids. To qualify as CPLR biosolids, the following requirements must be met:

The ceiling concentrations for pollutants in Table 2-1 may not be exceeded.

Cumulative Pollutant Loading Rates (CPLRs) listed in Table 2-1 may be not be exceeded.

## FIGURE 2-5
## Examples of Crops Impacted by Site Restrictions for Class B Biosolids

| Harvested Parts That: | | |
|---|---|---|
| **Usually Do Not Touch the Soil/Biosolids Mixture** | **Usually Touch the Soil/Biosolids Mixture** | **Are Below the Soil/Biosolids Mixture** |
| Peaches<br>Apples<br>Oranges<br>Grapefruit<br>Corn<br>Wheat<br>Oats<br>Barley<br>Cotton<br>Soybeans | Melons<br>Strawberries<br>Eggplant<br>Squash<br>Tomatoes<br>Cucumbers<br>Celery<br>Cabbage<br>Lettuce | Potatoes<br>Yams<br>Sweet Potatoes<br>Rutabaga<br>Peanuts<br>Onions<br>Leeks<br>Radishes<br>Turnips<br>Beets |

?

Either the Class A or Class B pathogen requirements in Table 2-5 must be met.

One of the 10 vector attraction reduction options in Table 2-6 must be met.

Frequency of monitoring (see Table 2-7), as well as recordkeeping and reporting requirements (see Table 2-8) must be met.

Applicable site restrictions, general requirements, and management practices must be met (summarized in Tables 2-3 and 2-4 and listed in Figures 2-4, 2-8, and 2-9).

The CPLR is the maximum amount of regulated pollutants in biosolids that can be applied to a site considering all biosolids applications made after July 20, 1993. When the CPLR for any one of the 10 heavy metals listed in Table 2-1 is reached at a site, no additional bulk biosolids, subject to the CPLR limits, may be applied to the site.

### Option 4: Annual Pollutant Loading Rate (APLR) Biosolids

The fourth option only applies to biosolids that are sold or given away in a bag or other container for application to land. Under this option, the following requirements must be met:

The ceiling concentrations for pollutants in Table 2-1 may not be exceeded.

The Annual Pollutant Loading Rates (APLRs) listed in Table 2-1 may not be exceeded.

The Class A pathogen requirements in Table 2-5 must be met.

One of the first eight vector attraction reduction options in Table 2-6 must be met.

The frequency of monitoring as well as recordkeeping and reporting requirements in Tables 2-7 and 2-8 must be met.

Applicable site restrictions, general requirements, and management practices must be met (summarized in Tables 2-3 and 2-4 and listed in Figures 2-4, 2-8, and 2-9).

An APLR is the maximum amount of regulated pollutants in biosolids that can be applied to a site in any 1 year. APLRs rather than CPLRs are used for biosolids sold or given away in a bag or other container because tracking the amount of pollutants applied in biosolids is not feasible in this situation.

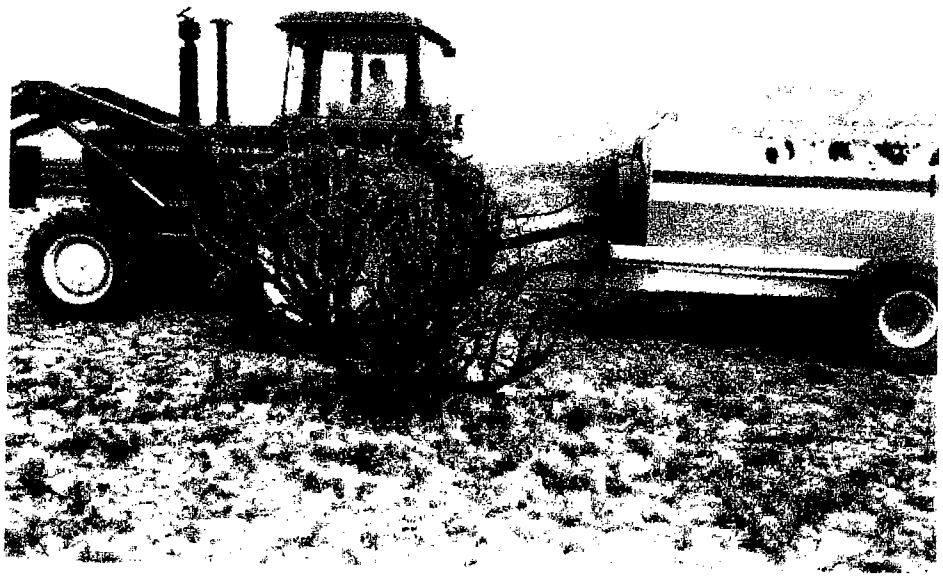
A labeling requirement for bagged or containerized APLR biosolids is discussed in Figure 2-9. To meet the labeling requirement, the preparer of biosolids must calculate the amount of biosolids that can be applied to a site during the year so that none of the APLRs are exceeded. This amount of biosolids is referred to as the annual whole sludge application rate (AWSAR). The AWSAR can be determined once the pollutant concentrations in the biosolids are known. The procedure for determining the AWSAR is explained in Figure 2-6. The AWSAR must be calculated for each of the 10 metals listed in Table 2-1, and the lowest AWSAR for the 10 metals is the allowable AWSAR for the biosolids. The AWSAR on the required label or information sheet has to be equal to or less than the AWSAR calculated using the procedure in Figure 2-6.

While not required by the Part 503 rule, it would also be good practice to provide information about the nitrogen content of the biosolids as well as the AWSAR on the label or information sheet that accompanies the biosolids. Figure 2-7 shows calculations that can be useful for determining how much nitrogen is being applied to land relative to the AWSAR and the nitrogen requirements of the plants being grown.

## General Requirements and Management Practices

The Part 503 general requirements and management practices must be met for all but EQ biosolids. The specific general requirements and kinds of management practices that apply to each type of biosolids are given in Figures 2-8 and 2-9, respectively. Several of the management practices are singled out for a bit more discussion below.

*Grain growing in sandy soil without (left) and with (right) anaerobically digested biosolids in Yuma, Arizona.*



*Biosolids are applied on a semi-arid rangeland demonstration study site in Rio Puerco, New Mexico.*

## FIGURE 2-6
## Procedure To Determine the Annual Whole Sludge (Biosolids) Application Rate for Biosolids Sold or Given Away in a Bag or Other Container

1. Analyze a sample of the biosolids to determine the concentration of each of the 10 regulated metals in the biosolids.
2. Using the pollutant concentrations from Step 1 and the APLRs from Table 2-1, calculate an AWSAR for each pollutant using equation (1) below:

$$AWSAR = \frac{APLR}{C \cdot 0.001} \text{ where:}$$

$AWSAR$ = Annual whole sludge (biosolids) application rate (dry metric tons of biosolids/hectare/year)
$APLR$ = Annual pollutant loading rate (in Table 2-1) (kg of pollutant/ha/yr)
$C$ = Pollutant concentration (mg of pollutant/kg of biosolids, dry weight)
0.001 = A conversion factor

3. The AWSAR for the biosolids is the lowest AWSAR calculated for each pollutant in Step 2.

Example:

1. Biosolids to be applied to land are analyzed for each of the 10 metals regulated in Part 503. Analysis of the biosolids indicates the pollutant concentration in the second column of the table below.
2. Using these test results and the APLR for each pollutant from Table 2-1, the AWSAR for all the pollutants are calculated as shown in the fourth column of the table below.
3. The AWSAR for the biosolids is the *lowest* AWSAR calculated for all 10 metals. In our example, the lowest AWSAR is for copper at 20 metric tons of biosolids/hectare/year. Therefore, the controlling AWSAR to be used for the biosolids is 20 metric tons per hectare/year. The 20 metric tons of biosolids/hectare is the same as 410 pounds of biosolids/1,000 square feet (20 metric tons × 2,205 lb per metric ton/107,600 square feet per hectare). The AWSAR on the label or information sheet would have to be equal to or less than 410 pounds per 1,000 square feet.

| Metal | Biosolids Concentrations (milligrams/kilogram) | APLR* (kilograms/ hectare/year) | AWSAR = $\frac{\text{APLR}}{\text{Conc. in Biosolids (0.001)}}$ = metric tons/hectare |
|---|---|---|---|
| Arsenic | 10 | 2.0 | 2 / (10 x 0.001) = 200 |
| Cadmium | 10 | 1.9 | 1.9 / (10 x 0.001) = 190 |
| Chromium | 1,000 | 150 | 150 / (1,000 x 0.001) = 150 |
| Copper | 3,750 | 75 | 75 / (3,750 x 0.001) = 20 |
| Lead | 150 | 15 | 15 / (150 x 0.001) = 100 |
| Mercury | 2 | 0.85 | 0.85 / (2 x 0.001) = 425 |
| Nickel | 100 | 21 | 21 / (100 x 0.001) = 210 |
| Selenium | 15 | 5.0 | 5 / (15 x 0.001) = 333 |
| Zinc | 2,000 | 140 | 140 / (2,000 x 0.001) = 70 |

* Annual Pollutant Loading Rate from Table 2-1 of this guide and Table 4 of the Part 503 rule.

## FIGURE 2-7
## Procedure for the Applier To Determine the Amount of Nitrogen Provided by the AWSAR Relative to the Agronomic Rate

In Figure 2-6, the AWSAR for the biosolids in the example calculation was determined to be 410 pounds of biosolids per 1,000 square feet of land. If biosolids were to be placed on a lawn that has a nitrogen requirement of about 200 pounds* of available nitrogen per acre per year, the following steps would determine the amount of nitrogen provided by the AWSAR relative to the agronomic rate if the AWSAR was used:

1. The nitrogen content of the biosolids indicated on the label is 1 percent total nitrogen and 0.4 percent available nitrogen the first year.
2. The AWSAR is 410 pounds of biosolids per 1,000 square feet, which is 17,860 pounds of biosolids per acre:

$$\frac{410 \text{ lb}}{1{,}000 \text{ sq ft}} \times \frac{43{,}560 \text{ sq ft}}{\text{acre}} \times 0.001 = \frac{17{,}860 \text{ lb}}{\text{acre}}$$

3. The available nitrogen from the biosolids is 71 pounds per acre:

$$\frac{17{,}860 \text{ lb biosolids}}{\text{acre}} \times .004 = \frac{71 \text{ lb}}{\text{acre}}$$

4. Since the biosolids application will only provide 71 pounds of the total 200 pounds of nitrogen required, in this case the AWSAR for the biosolids will not cause the agronomic rate for nitrogen to be exceeded and an additional 129 pounds per acre of nitrogen would be needed from some other source to supply the total nitrogen requirement of the lawn.

*Assumptions about crop nitrogen requirement, biosolids nitrogen content, and percent of that nitrogen that is available are for illustrative purposes only.

## TABLE 2-7
## Frequency of Monitoring for Pollutants, Pathogen Densities, and Vector Attraction Reduction

| Amounts of Biosolids* (metric tons per 365-day period) | Amount of Biosolids (English tons) | | Frequency |
|---|---|---|---|
| | Avg. per day | per 365 days | |
| Greater than zero but less than 290 | >0 to <0.85 | >0 to <320 | Once per year |
| Equal to or greater than 290 but less than 1,500 | 0.85 to <4.5 | 320 to <1,650 | Once per quarter (4 times per year) |
| Equal to or greater than 1,500 but less than 15,000 | 4.5 to <45 | 1,650 to <16,500 | Once per 60 days (6 times per year) |
| Equal to or greater than 15,000 | ≥45 | ≥16,500 | Once per month (12 times per year) |

* Either the amount of bulk biosolids applied to the land or the amount of biosolids received by a person who prepares biosolids for sale or give-away in a bag or other container for application to the land (dry-weight basis).

# FIGURE 2-8
## Part 503 Land Application General Requirements

**For EQ Biosolids**

None (unless set by EPA or State permitting authority on a case-by-case basis for bulk biosolids to protect public health and the environment).

**For PC and CPLR Biosolids**

The ***preparer**** must notify and provide information necessary to comply with the Part 503 land application requirements to the person who applies bulk biosolids to the land.

The ***preparer*** who provides biosolids to another person who further prepares the biosolids for application to the land must provide this person with notification and information necessary to comply with the Part 503 land application requirements.

The ***preparer*** must provide written notification of the total nitrogen concentration (as N on a dry-weight basis) in bulk biosolids to the applier of the biosolids to agricultural land, forests, public contact sites, or reclamation sites.

The ***applier*** of biosolids must obtain information necessary to comply with the Part 503 land application requirements, apply biosolids to the land in accordance with the Part 503 land application requirements, and provide notice and necessary information to the owner or leaseholder of the land on which biosolids are applied.

**Out of State Use**

The ***preparer*** must provide written notification (prior to the initial application of the bulk biosolids by the applier) to the permitting authority in the State where biosolids are proposed to be land applied when bulk biosolids are generated in one State and transferred to another State for application to the land. The notification must include:

- the location (either street address or latitude and longitude) of each land application site;
- the approximate time period the bulk biosolids will be applied to the site;
- the name, address, telephone number, and National Pollutant Discharge Elimination System (NPDES) permit number for both the preparer and the applier of the bulk biosolids; and
- additional information or permits in both States, if required by the permitting authority.

**Additional Requirements for CPLR Biosolids**

The ***applier*** must notify the permitting authority in the State where bulk biosolids are to be applied prior to the initial application of the biosolids. This is a one-time notice requirement for each land application site each time there is a new applier. The notice must include:

- the location (either street address or latitude and longitude) of the land application site; and
- the name, address, telephone number, and NPDES permit number (if appropriate) of the person who will apply the bulk biosolids.

The ***applier*** must obtain records (if available) from the previous applier, landowner, or permitting authority that indicate the amount of each CPLR pollutant in biosolids that have been applied to the site since July 20, 1993. In addition:

- when these records are available, the ***applier*** must use this information to determine the additional amount of each pollutant that can be applied to the site in accordance with the CPLRs in Table 2-1;
- the ***applier*** must keep the previous records and also record the additional **amount of each pollutant he or she is applying to the site**; and
- when records of past known CPLR applications since July 20, 1993, are not available, biosolids meeting CPLRs cannot be applied to that site. However, EQ or PC biosolids could be applied.

If biosolids meeting CPLRs have not been applied to the site in excess of the limit since July 20, 1993, the CPLR limit for each pollutant in Table 2-1 will determine the maximum amount of each pollutant that can be applied in biosolids if:

- all applicable management practices are followed; and
- the applier keeps a record of the amount of each pollutant in biosolids applied to any given site.

The ***applier*** must not apply additional biosolids under the cumulative pollutant loading concept to a site where any of the CPLRs have been reached.

* The preparer is either the person who generates the biosolids or the person who derives a material from biosolids.

# FIGURE 2-9
## Part 503 Land Application Management Practice Requirements

**For EQ Biosolids**

None (unless established by EPA or the State permitting authority on a case-by-case basis for bulk biosolids to protect public health and the environment).

**For PC and CPLR Biosolids**

These types of biosolids cannot be applied to flooded, frozen, or snow-covered agricultural land, forests, public contact sites, or reclamation sites in such a way that the biosolids enter a wetland or other waters of the United States (as defined in 40 CFR Part 122.2, which generally includes tidal waters, interstate and intrastate waters, tributaries, the territorial sea, and wetlands adjacent to these waters), except as provided in a permit issued pursuant to Section 402 (NPDES permit) or Section 404 (Dredge and Fill Permit) of the Clean Water Act, as amended.

These types of biosolids cannot be applied to agricultural land, forests, or reclamation sites that are 10 meters or less from U.S. waters, unless otherwise specified by the permitting authority.

If applied to agricultural lands, forests, or public contact sites, these types of biosolids must be applied at a rate that is equal to or less than the agronomic rate for nitrogen for the crop to be grown. Biosolids applied to reclamation sites may exceed the agronomic rate for nitrogen as specified by the permitting authority.

These types of biosolids must not harm or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of the species' critical habitat when applied to the land. Threatened or endangered species and their critical habitats are listed in Section 4 of the Endangered Species Act. Critical habitat is defined as any place where a threatened or endangered species lives and grows during any stage of its life cycle. Any direct or indirect action (or the result of any direct or indirect action) in a critical habitat that diminishes the likelihood of survival and recovery of a listed species is considered destruction or adverse modification of a critical habitat.

**For APLR Biosolids**

A label must be affixed to the bag or other container, or an information sheet must be provided to the person who receives APLR biosolids in other containers. At a minimum, the label or information sheet must contain the following information:

- the name and address of the person who prepared the biosolids for sale or giveaway in a bag or other container;
- a statement that prohibits application of the biosolids to the land except in accordance with the instructions on the label or information sheet;
- an AWSAR (see Figure 2-6) for the biosolids that do not cause the APLRs to be exceeded; and
- the nitrogen content.

There is no labeling requirement for EQ biosolids sold or given away in a bag or other container.

### Endangered Species

The Part 503 rule prohibits the application of bulk biosolids to land if it is likely to adversely affect endangered or threatened species or their designated critical habitat. Any direct or indirect action that reduces the likelihood of survival and recovery of an endangered or threatened species is considered an "adverse effect." Critical habitat is any place where an endangered or threatened species lives and grows during its life cycle. The U.S. Department of Interior, Fish and Wildlife Service (FWS) publishes a list of endangered and threatened species at 50 CFR 17.11 and 17.12.

Practices that involve applying biosolids to lands (subjected to normal tillage, cropping, and grazing practices, or mining, forestry, and other activities that by their nature are associated with turning the soil and affecting vegetation) are not likely to result in any increase in negative impacts on endangered species and in fact may be beneficial given the nutritive and soil-building properties of biosolids. It is the responsibility of the land applier, however, to determine if the application of biosolids might cause an adverse effect on an endangered species or its critical habitat. Moreover, the Part 503 rule requires the land applier to certify (Figure 2-10) that the applicable management practices have been met, including the requirement concerning endangered species, and that records are kept indicating how the applicable management practices have been met.

One recommended step for making the threatened and endangered species determination is to contact the FWS Endangered Species Protection Program in Washington, DC (703-358-2171), or one of the FWS Field Offices, listed in Appendix C, for more information about the general area being considered for land application. State fish and game departments also can be contacted for specific state requirements.

### Flooded, Frozen, or Snow-Covered Land

Application of biosolids to flooded, frozen, or snow-covered land is not prohibited by the Part 503 rule. Appliers must ensure, however, that biosolids applied to such land does not enter surface waters or wetlands unless specifically authorized by a permit issued under Sections 402 or 404 of the Clean Water Act (CWA). Some common runoff controls include slope restrictions, buffer zones/filter strips, tillage to create a roughened soil surface, crop residue or vegetation, berms, dikes, silt fences, diversions, siltation basins, and terraces.

### Distance to U.S. Waters

Bulk biosolids may not be applied within 10 meters (33 feet) of any waters of the United States (e.g., intermittent following streams, creeks, rivers, wetlands, or lakes) unless otherwise specified by the permitting authority. Permitting authorities can allow exceptions to this requirement if the application of biosolids is expected to enhance the local environment. For

example, biosolids application may help revegetate a stream bank and otherwise minimize erosion. Approval of such biosolids application could be given via letters of authorization under Section 308 of the CWA, a settlement agreement, or a permit.

### Agronomic Rate

The ***agronomic rate*** for biosolids application is a rate that is designed to provide the amount of nitrogen needed by a crop or vegetation to attain a desired yield while minimizing the amount of nitrogen that will pass below the root zone of the crop or vegetation to the ground water. Crop-available nitrogen in biosolids that is applied in excess of the agronomic rate could result in nitrate contamination of the ground water. The Part 503 rule requires that the rate of land application for bulk biosolids be equal to or less than the agronomic rate, except in the case of a reclamation site where a different rate of application is allowed by the permitting authority. Approval could be given via letters of authorization under Section 308 of the CWA, a settlement agreement, or a permit.

Although the preparer is required to supply the land applier with information on the nitrogen content of the biosolids, the land applier is responsible for determining that the biosolids are applied at a rate that does not exceed the agronomic rate for that site. Procedures for the design of the agronomic rate differ depending on such factors as the total and available nitrogen content of the biosolids, nitrogen losses, nitrogen from sources other than biosolids (including estimates or measurements of available nitrogen already present in the soil), and the requirements for the expected yield of crop or vegetation. Assistance in designing the agronomic rate should be obtained from a knowledgeable person, such as the local extension agent or the soil testing department at the Land Grant University in each state. (A sample calculation of the nitrogen supplied by biosolids based on the AWSAR is provided in Figure 2-7.)

## Frequency of Monitoring Requirements

Pollutants, pathogen densities, and vector attraction reduction must be monitored when biosolids are applied to the land. This monitoring ensures that pollutant limits and pathogen and vector attraction reduction requirements are being met. Chapter Six describes the sampling and analytical procedures to be followed. The required frequency of monitoring is 1, 4, 6, or 12 times per year, depending on the number of metric tons (mt) (dry-weight basis) of biosolids used or disposed in that year. This frequency is presented in Table 2-7. Frequency of monitoring requirements must be met regardless of which option is chosen for meeting pollutant limits and pathogen and vector attraction reduction requirements, with the exception of Class B pathogen Alternative 2.

# TABLE 2-8
## Recordkeeping and Reporting Requirements

| Type of Biosolids | Records That Must Be Kept | Person Responsible for Recordkeeping | | Records That Must Be Reported[a] |
|---|---|---|---|---|
| | | Preparer | Applier | |
| EQ Biosolids | Pollutant concentrations | ✓ | | ✓ |
| | Pathogen reduction certification and description | ✓ | | ✓ |
| | Vector attraction reduction certification and description | ✓ | | ✓ |
| PC Biosolids | Pollutant concentrations | ✓ | | ✓ |
| | Management practice certification and description | | ✓ | |
| | Site restriction certification and description (where Class B pathogen requirements are met) | | ✓ | |
| | Pathogen reduction certification and description | ✓ | | ✓ |
| | Vector attraction reduction certification and description | ✓ | ✓[b] | ✓[c] |
| CPLR Biosolids | Pollutant concentrations | ✓ | | ✓ |
| | Management practice certification and description | | ✓ | |
| | Site restriction certification and description (if Class B pathogen requirements are met) | | ✓ | |
| | Pathogen reduction certification and description | ✓ | | ✓ |
| | Vector attraction reduction certification and description | ✓ | ✓[b] | ✓[c] |
| | Other information:<br>— Certification and description of information gathered (information from the previous applier, landowner, or permitting authority regarding the existing cumulative pollutant load at the site from previous biosolids applications)<br>— Site location<br>— Number of hectares<br>— Amount of biosolids applied<br>— Cumulative amount of pollutant applied (including previous amounts)<br>— Date of application | | ✓ | ✓[d] |
| APLR Biosolids | Pollutant concentrations | ✓ | | ✓ |
| | Management practice certification and description | ✓ | | ✓ |
| | Pathogen reduction certification and description | ✓ | | ✓ |
| | Vector attraction reduction certification and description | ✓ | | ✓ |
| | The AWSAR for the biosolids | ✓ | | ✓ |

[a] Reporting responsibilities are only for POTWs with a design flow rate equal to or greater than 1 mgd, POTWs that serve a population of 10,000 or greater, and Class I sludge management facilities.

[b] The preparer certifies and describes vector attraction reduction methods other than injection and incorporation of biosolids into the soil. The applier certifies and describes injection or incorporation of biosolids into the soil.

[c] Records that certify and describe injection or incorporation of biosolids into the soil do not have to be reported.

[d] Some of this information has to be reported only when 90 percent or more of any of the CPLRs is reached at a site.

## Recordkeeping and Reporting Requirements

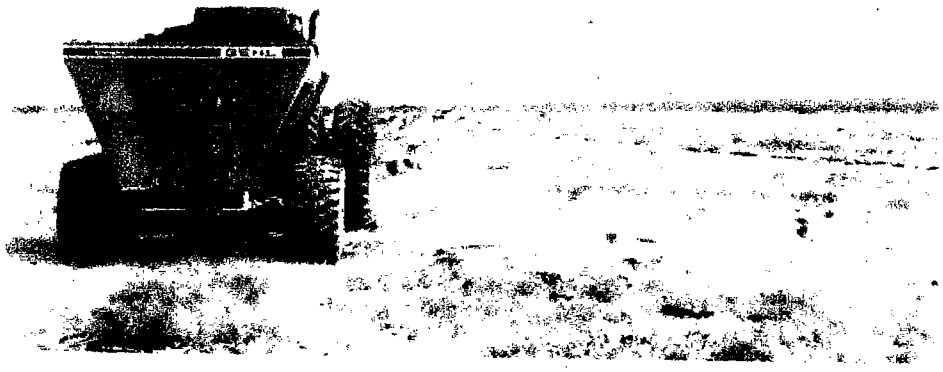
Part 503 requires that certain records be kept by the person who ***prepares*** biosolids for application to the land and the person who ***applies*** biosolids to the land. The recordkeeping and reporting requirements are summarized in Table 2-8. Some of the records that must be kept when biosolids are applied to the land include statements certifying whether certain land application requirements are met. The general certification statement that must be used is provided as Figure 2-10. This statement certifies that, among other things, the land applier and his or her employees are qualified to gather information and perform tasks as required by the Part 503 rule.

The certifier should periodically check the performance of his or her employees to verify that the Part 503 requirements are being met. Then, when a Federal or State inspector checks the employee's logs, office records, and performance in the field, the inspector should find that the required management practices are being followed and that any applicable pathogen and vector attraction reduction requirements, including associated crop harvesting, animal grazing, and site access restrictions, are being met. The inspector also should find that all other necessary records and requirements listed in Table 2-8 are in order. Even if the preparer/applier is not required to report this information, he or she must keep these records for 5 years, or indefinitely for cumulative amounts of pollutants added to any site by CPLR biosolids. These required records may be requested for review at any time by the permitting or enforcement authority.

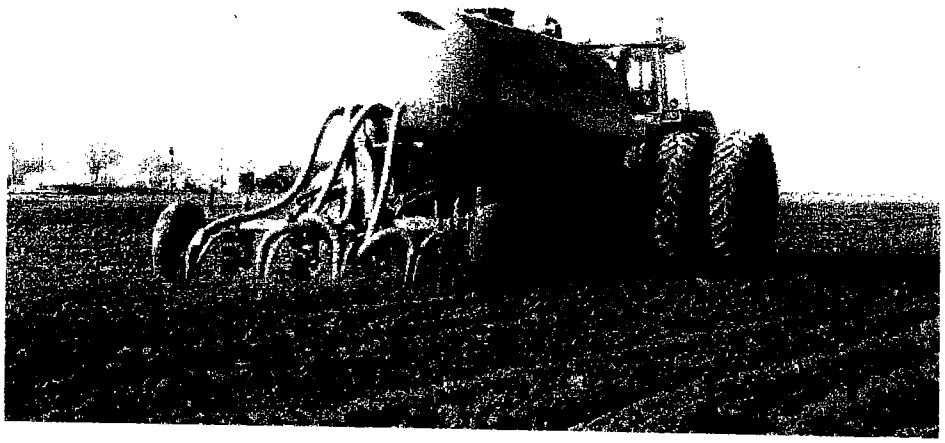
### FIGURE 2-10
### Certification Statement Required for Recordkeeping

"I certify under penalty of law, that the *[insert each of the following requirements that are met: Class A or Class B pathogen requirements, vector attraction reduction requirements, management practices, site restrictions, requirements to obtain information]* in *[insert the appropriate section number/s in Part 503 for each requirement met]* have/have not been met. This determination has been made under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate the information used to determine that the requirements have been met. I am aware that there are significant penalties for false certification, including the possibility of fine and imprisonment."

Signature _____ Date _____



*Top-flinging applicator spreads dewatered biosolids from a New York City wastewater treatment works onto a site in Texas.*



*Anaerobically digested biosolids from Los Angeles are injected into the soil in California.*

Some facilities are not subject to any Part 503 reporting requirements. However, all Class I treatment works, treatment works serving a population of 10,000 or more, and treatment works with a 1 mgd or greater design flow (as described in the first chapter of this guidance) have reporting responsibilities. Each year, facilities with reporting requirements must submit some of the information contained in their records (according to Table 2-8). The information must be submitted every February 19th to the permitting authority (either EPA or a State with an EPA-approved biosolids management program).

## Domestic Septage

Part 503 imposes separate requirements for domestic septage applied to agricultural land, forest, or a reclamation site (i.e., nonpublic-contact sites). The "simplified rule" for application of domestic septage to such sites is explained in ***Domestic Septage Regulatory Guidance: A Guide to the EPA 503 Rule.*** If domestic septage is applied to public contact sites or home lawns and gardens, the same requirements must be met as for bulk biosolids applied to the land (i.e., general requirements, pollutant limits, pathogen and vector attraction reduction requirements, management practices, frequency of monitoring requirements, and recordkeeping and reporting requirements).

## Landowner and Leaseholder Responsibilities

If the landowner or leaseholder is also the land applier of the biosolids, that person must follow the applicable provisions of the Part 503 rule for land appliers as described in this chapter. If the land-applying operation is of sufficient size or concern to the permitting authority, the landowner or leaseholder applier might also be required to obtain a permit for the land application activities.

If the landowner or leaseholder is not the land applier (e.g., the applier is a contractor or biosolids generator/preparer), the landowner or leaseholder might wish to obtain certain information and maintain certain records even though not required by the Part 503 rule. For example, he or she might wish to keep records on information that Part 503 requires the land applier to give to the landowner or leaseholder for any site where cropping or grazing restrictions apply.

Additional information that the landowner or leaseholder should obtain from the biosolids preparer and/or land applier is the nutritive value (i.e., the amount of each available nutrient such as nitrogen, potassium, phosphorus, and lime being applied), so that he or she will not over-apply any supplemental fertilizers. Also, if biosolids are being applied to the land in accordance with the CPLR concept, it would be prudent for the landowner

or leaseholder to make sure that he or she is given and retains information on the cumulative totals of pollutants that have been added to each parcel of land so that more CPLR biosolids can be applied each year until the cumulative limits for CPLR biosolids have been reached.

The landowner or leaseholder might wish to obtain assurances via an agreement that any biosolids being land applied are of an appropriate quality and have been sufficiently prepared and that the application procedures used meet the requirements of the Part 503 rule. One possible agreement between the landowner or leaseholder and land applier might be:

> **Contractor agrees to indemnify, defend, and hold harmless [Landowner/Leaseholder] from and against any and all claims, suits, actions, demands, losses, costs, liabilities, and expenses (including remediation costs and reasonable attorney's fees) to the extent such losses result from: (1) Contractor's or Generator/Preparer's violation of applicable laws or regulations in effect at the time of biosolids application; or (2) the negligence or willful misconduct of Contractor in delivery and application of biosolids to the undersigned Landowner/ Leaseholders' property. In the event this indemnification is enforced against the Contractor for a violation of law by a Generator/Preparer, Landowner/Leaseholder agrees to assign and subrogate to Contractor its claim against Generator/ Preparer. This indemnification shall survive termination of this Agreement until the expiration of any applicable statutes of limitations. Landowner/Leaseholder shall promptly notify Contractor in the event of a third-party claim and Contractor shall have the right to provide and oversee the defense of such claim and enter into any settlement of such claim at its discretion (holding the Landowner/Leaseholder harmless). Landowner/Leaseholder agrees to fully cooperate with Contractor in the defense against any third-party claim.**

# Liability Issues and Enforcement Oversight

Remember that the Part 503 rule is self-implementing and that its provisions must be followed whether or not a permit is issued. Remember also that State rules, which may be different from and more stringent than the Part 503 rule, may also apply.

EPA's Part 503 rule concerning the use or disposal of biosolids includes enforcement measures regarding the proper testing and application of biosolids. Landowners (including their lenders) and leaseholders who use biosolids beneficially as a fertilizer substitute or soil conditioner in

accordance with EPA's Part 503 rule are protected from liability under the Superfund legislation (Comprehensive Environmental Response, Compensation and Liability Act—CERCLA) (see 58 *Federal Register* 9262, February 19, 1993) as well as any enforcement action from EPA under the Part 503 rule. Where the Federal requirements are not followed, appliers of biosolids are vulnerable to EPA enforcement actions or citizen-initiated suits and can be required to remediate any problems for which they are found liable.

There is concern that if for some reason the application of biosolids to farmland might result in damage to crops, livestock, or the land itself, a farmer or the farmer's lender may be exposed to significant financial loss. There is also concern about possible future loss that might occur if unanticipated hazards from previous biosolids use are discovered. While there are no guarantees, past experience with agronomic use of biosolids is very reassuring. Where biosolids have been applied in accordance with Federal and State regulations, problems have been rare and virtually the same as those that have occurred from normal farming practices. Available research indicates that the agronomic use of high-quality biosolids is sustainable.

EPA oversight of land application practices includes a program for administering permits and for monitoring, reporting, and inspecting. As with wastewater discharge standards and requirements, preparers and land appliers are required to keep detailed records and Class I biosolids management facilities must self-report on their activities during the preceding calendar year by February 19th. As described in Table 2-8, the reports must include information on biosolids quality. In the case of CPLR biosolids, a field-by-field analysis of the site activity must also be reported, including information on management practices and on the cumulative application of metals. Hence, EPA will know the quality of the biosolids and where they are going, in accordance with EPA Part 503 requirements.

EPA will not rely solely on the word of the regulated community. The Agency will conduct routine sampling and inspections of these facilities. If discrepancies are identified, enforcement actions will be taken. Enforcement actions can include fines of up to $25,000 per day per violation, injunctive relief, or criminal imprisonment.

EPA shares the concern regarding the potential for harm from the misapplication of biosolids (i.e., not in accordance with general or management practices) or the failure to meet quality or treatment requirements. Notwithstanding, EPA believes that the Part 503 rule is protective and that most land application activities will be in compliance with its requirements.

# Common Questions and Answers

***Q: EPA has an enforcement strategy that focuses on EQ biosolids first and then addresses biosolids meeting more burdensome requirements. Why?***

A: Biosolids that meet the EQ criteria are exempt from further consideration (i.e., management practices or tracking requirements) under the rule. This means that EQ biosolids may be used to supply plant nutrients and to condition soils, such as commercial fertilizers and other soil amending products, after meeting the EQ criteria. If biosolids that are claimed as EQ do not meet these requirements, then it is not possible to know if the untracked non-EQ biosolids are being used in accordance with other applicable provisions of the Part 503 rule and there could be a potential for adverse environmental and public health impacts. Therefore, it is crucial, from a public health and environment standpoint, to ensure that biosolids truly meet these EQ requirements. That is why EPA chose to focus first on EQ biosolids.

***Q: The Part 503 rule states that its requirements apply to any person who prepares [biosolids], applies [biosolids] to land, fires [biosolids] in an incinerator, or owns or operates a surface disposal site. The Part 503 rule defines a person as an individual, association, partnership, corporation, municipality, or a State or Federal agency or an agent or employee thereof. EQ biosolids are not subject to general requirements or management practices. If the biosolids are distributed as EQ and later found not to be EQ, will all the individuals who apply the biosolids to land be considered to have violated the Part 503 rule? Who is ultimately responsible?***

A: The generator and/or preparer, and possibly in some unique cases the land applier, would be liable. Whom EPA targets for enforcement action would depend on the specifics of the situation. It is highly unlikely that EPA would target any individual user or land applier of such alleged EQ biosolids material. In many cases, the user or land applier might not even know that he or she was using a biosolids product.

***Q: What happens to sites that reach the CPLR? Can you ever reuse or repermit that site?***

A: Once a site reaches the CPLR, that site can no longer have biosolids subject to the CPLR concept applied to it. You could, however, continue to apply biosolids that meet the EQ or PC requirements.

***Q: If EQ or PC biosolids are land applied, do you need to keep records of cumulative application rates? If non-EQ or non-PC biosolids are subsequently applied to the same land, do you have to consider the pollutants land applied in the EQ or PC biosolids?***

A: Part 503 does not require land appliers to keep track of the cumulative amounts of pollutants in EQ or PC biosolids that are applied to a particular parcel of land. The applier of any biosolids that are subject to CPLRs are not required by Part 503 to consider the pollutant loadings already applied to the same parcel of land from EQ or PC biosolids.

***Q: When biosolids from a Class I facility are land applied, exactly what information must be reported regarding biosolids pollutant levels and pathogen and vector attraction reduction?***

A: On February 19 of each year, the preparer and land applier, as applicable, would be required to submit on the previous year the following information to the permitting authority:

- the concentration in biosolids of each pollutant listed in Table 2-1 of this guidance;
- the appropriate certification statement indicating the Class A and B pathogen reduction and vector attraction reduction options used; and
- a description of how the preparer/applier is meeting the requirements of the pathogen and vector attraction reduction options chosen. In general, the preparer/applier would not need to report the actual data collected on pathogens or related to vector attraction reduction; however, the preparer/applier would need to describe how the required limiting numbers have been met or exceeded and how required operating parameters have been maintained. In addition, the preparer/applier must retain the actual data collected for a minimum of 5 years and have it available for inspection by authorized permitting or regulatory authorities when requested. Pollutant loading rate information must be kept indefinitely for CPLR biosolids on a site-by-site basis.

***Q: If biosolids are applied to land in accordance with the requirements of the Part 503 rule, would the landowner, leaseholder, mortgage lender, land applier, or generator/preparer be liable under CERCLA for the cost of any cleanup of soil or water contamination or loss of crops?***

A: No. Application of sewage sludge for a beneficial purpose in compliance with the Part 503 rule would not give rise to CERCLA liability.

***Q: Does EPA believe there is an environmental or public health problem related to the beneficial use of biosolids in accordance with the Part 503 rule?***

A: It is EPA's long-standing position that the beneficial application of biosolids to provide crop nutrients or to condition the soil is not only safe but good public policy, so long as preparers and land appliers comply with all applicable requirements of the Part 503 rule. Among other things, those requirements address the quality of biosolids allowed for land application, the rates of application of biosolids under various circumstances, and monitoring. Beneficial use of biosolids reclaims a wastewater residual, converting it into a resource that is recycled to land. EPA's position on biosolids use is based on extensive research involving hundreds of successful land application projects over the past 25 years.