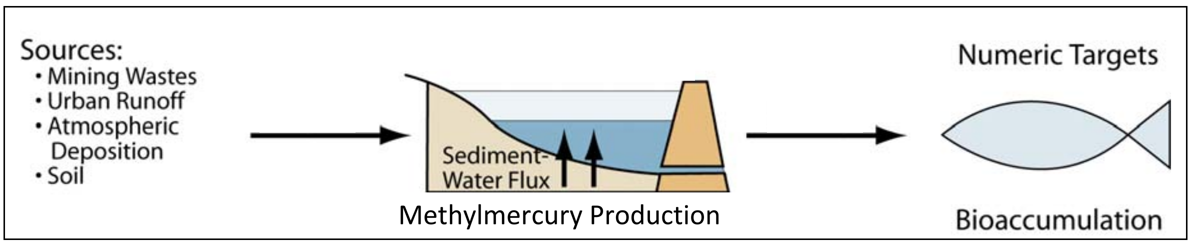
# Guadalupe River Watershed

## Mercury

## Total Maximum Daily Load (TMDL) Project

## STAFF REPORT

## For Proposed Basin Plan Amendment





**California Regional Water Quality Control Board**

**San Francisco Bay Region**

**September 2008**

## *Cover Illustrations*

### Figure 7.1 Linkage Between Sources, Methylmercury, and Targets

*Citation: Prepared by Tetra Tech under contract to Water Board*

This figure illustrates the indirect linkage between the sources of mercury and mercury in fish (numeric targets). They are linked by the sites where methylmercury is produced. We propose in this TMDL to both control mercury sources and bioaccumulation of methylmercury into fish.

### Great Seal of the State of California

California's gold mine legacy links the Great Seal of the State of California and this watershed. Mercury mined primarily from New Almaden in the headwaters of the Guadalupe River watershed was a key raw material used in the Gold Rush.

> *The Roman goddess of wisdom, Minerva, has at her feet a grizzly bear and clusters of grapes representing wildlife and agricultural richness. A miner works near the busy Sacramento River, below the Sierra Nevada peaks. The Greek word "Eureka" meaning "I have found it", probably refers to the miner's discovery of gold.*
>
> *Citation: California State Library*
> *http://www.library.ca.gov/history/symbols.html#Heading1*

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Many thanks to our editors who make our story coherent: Janet W. Cox, Ariel Rubissow-Okamoto, and Kathryn Ankrum.

We are indebted to the active participants in the Guadalupe Mercury Work Group, and to Tom Grieb, Sujoy Roy, and Karen Summers of Tetra Tech, for their considerable technical contributions to this TMDL project. Actions to reduce methylmercury production and bioaccumulation require innovative measures, such as adapting reservoir nutrient controls. David D. Drury, P.E., of the Santa Clara Valley Water District has the foresight and leadership to pursue these innovations. We wish him success in this important endeavor.

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# 1. Introduction

This Staff Report presents the supporting documentation for a proposed Basin Plan amendment (amendment) that will be considered by the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board). The amendment will establish new water quality objectives, total maximum daily loads (TMDLs), and an implementation plan for mercury in the portion of the Guadalupe River watershed downstream of mercury mines and in waters that receive urban runoff. The location of the Guadalupe River watershed is indicated on Figure 1.1, and the watershed itself is illustrated on Figure 1.2. The water quality objectives and TMDLs are proposed for the waters of the Guadalupe River watershed except Los Gatos Creek and its tributaries upstream of Vasona Dam, including Vasona Lake, Lexington Reservoir, and Lake Elsman (see Figure 1.2). The TMDL is based on attainment of fish tissue target mercury concentrations protective of human health, wildlife, and aquatic organisms. This report contains the results of analyses of mercury impairment assessments, sources and loadings, linkage analyses, load reductions, and implementation actions.

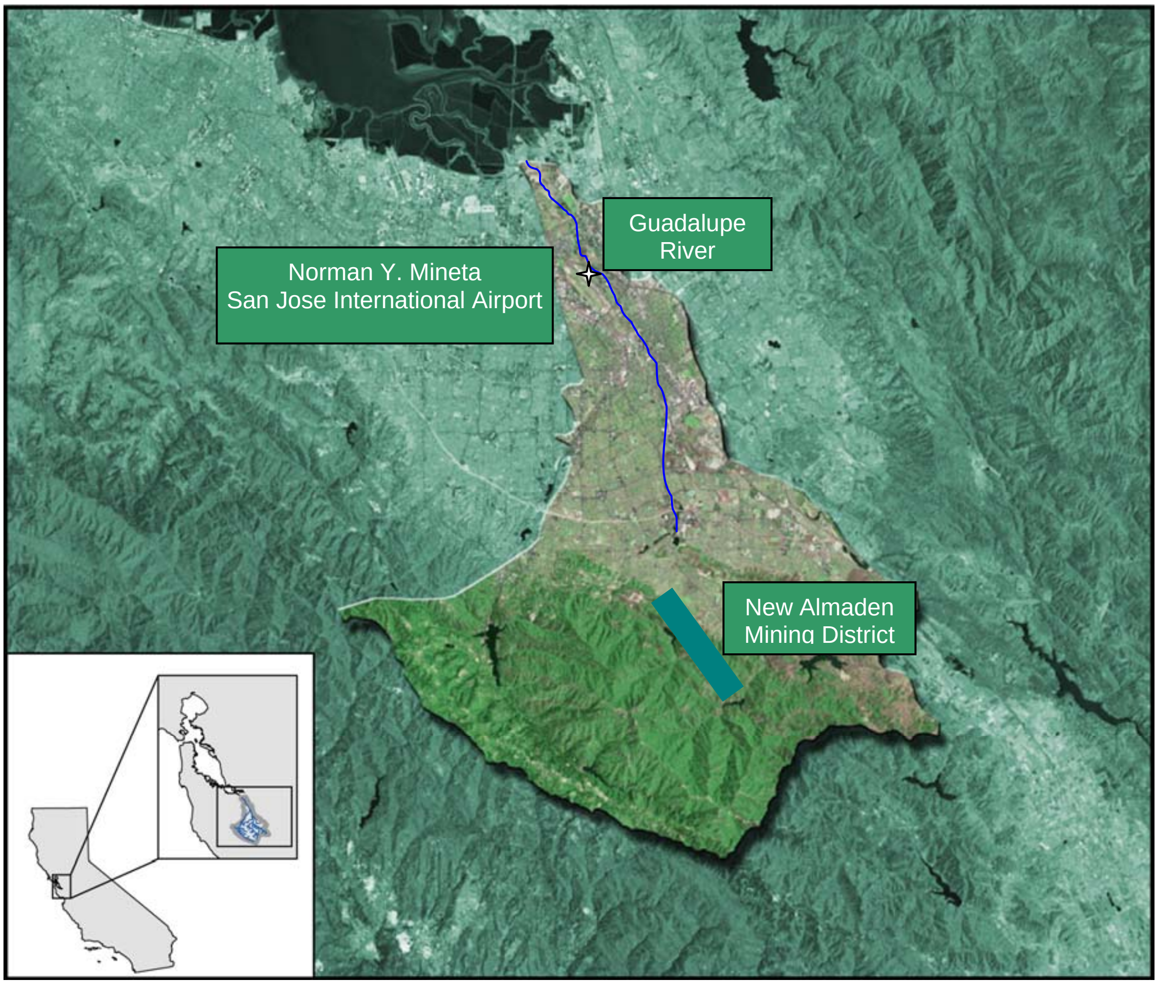


**Figure 1.1 Location of Guadalupe River Watershed**

*Citation: Figure ES-1 Final Conceptual Model Report (Tetra Tech 2005c)*

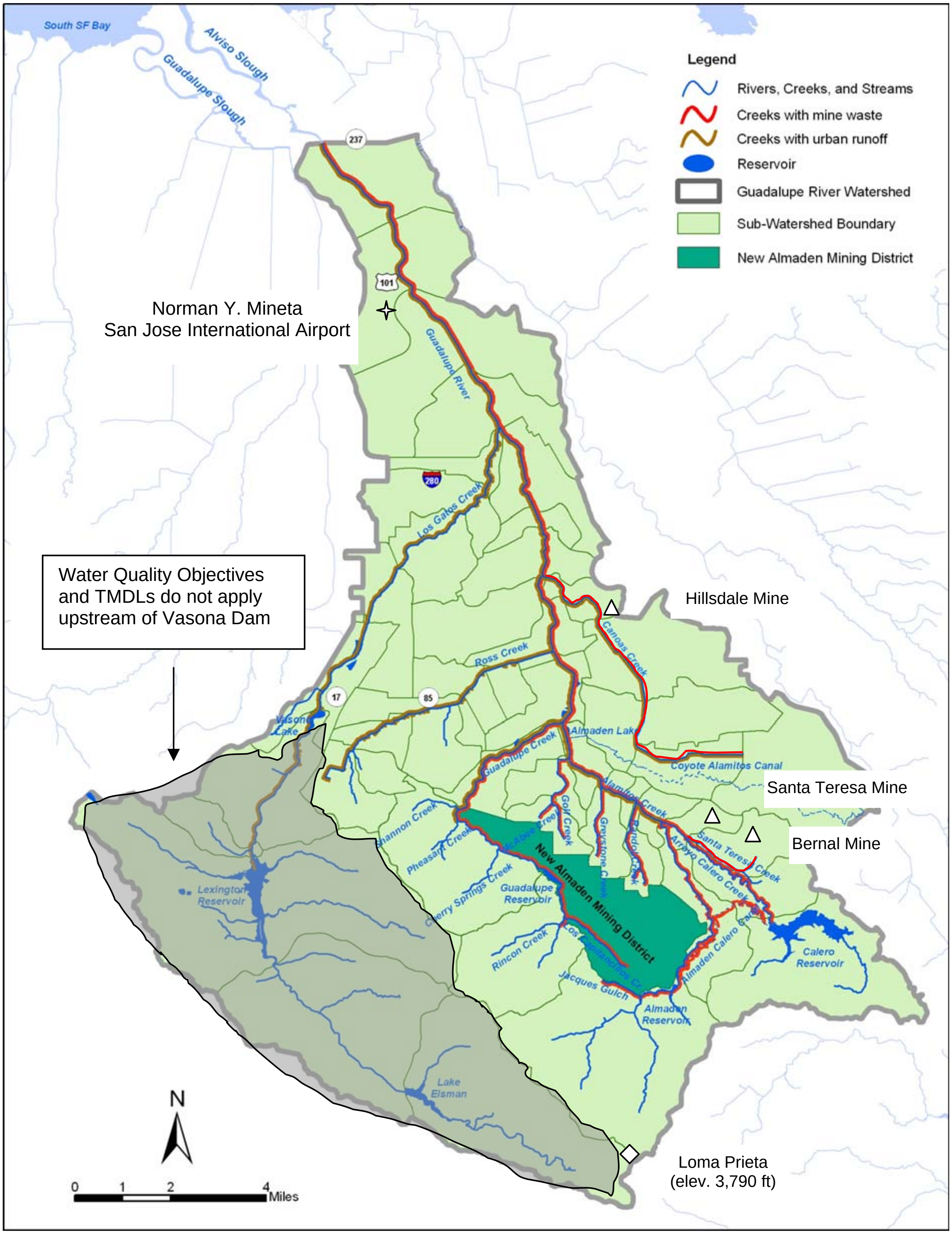


**Figure 1.2 Guadalupe River Watershed**

*Citation: Figure 2-2 Final Conceptual Model Report (Tetra Tech 2005c)*

The Clean Water Act requires California to adopt and enforce water quality standards to protect surface waters. The Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) delineates these standards, which include beneficial uses of waters in the Region, numeric and narrative water quality objectives to protect those uses, and provisions to enhance and protect existing water quality (antidegradation). Section 303(d) of the Clean Water Act requires states to compile a list of "impaired" water bodies that do not meet water quality standards and to establish a TMDL for the pollutant that causes impairment. The proposed TMDL and implementation plan are designed to resolve mercury impairment in waters downstream of mercury mines in the Guadalupe River watershed. A future TMDL and implementation plan will address mercury impairment in the remaining western portion of the watershed (Los Gatos Creek and its tributaries upstream of Vasona Dam, including Vasona Lake, Lexington Reservoir, and Lake Elsman, see Figure 1.2).

## 1.1 California Environmental Quality Act

This report provides the rationale and the technical basis for the required TMDL elements and associated implementation plan. This report meets the requirements of the California Environmental Quality Act (CEQA), including the preparation of a checklist (see Section 10) for adopting Basin Plan amendments and serves in its entirety as a substitute CEQA environmental document. It builds on earlier reports beginning with the January 2006 Project Report. The August 2007 Staff Report for Peer Review was developed with consideration of stakeholder input, including incorporation of the public comments received on the Project Report. This Staff Report for Public Comment has been revised based on the Peer Reviewer's comments.

## 1.2 Report Development and Organization

The process for establishing a TMDL includes compiling and considering available data and information, conducting appropriate analyses relevant to defining the impairment problem, identifying sources, and allocating responsibility for actions to resolve the impairment. This report is organized into sections that reflect background information, the key elements of the TMDL process, and regulatory analyses required to adopt the amendment.

In addition, the scientific basis of the Basin Plan amendment was subjected to external scientific peer review. This step is required under §57004 of the Health and Safety Code, which specifies that an external review is required for work products that serve as the basis for a rule, "…establishing a regulatory level, standard, or other requirements for the protection of public health or the environment." The scientific basis of the water quality objectives and mercury TMDLs, as presented herein, was evaluated by three peer reviewers who concluded that the scientific basis of the proposed Basin Plan amendment is based on sound scientific knowledge, methods, and practices (see Section 10.2).

This staff report is organized into the following sections. Sections 1 through 3 explain the problem and introduce the project. Section 1 (Introduction) provides background on this report and the TMDL process. Section 2 (Project Definition) provides the problem statement that the project is based on, and the project definition and objectives. Section 3 (Background) provides context, such as the watershed setting.

Sections 4 through 7 provide the key scientific analyses. Section 4 (Source Analysis) identifies and quantifies the various contributions of watershed mercury sources. Sections 5 and 6 (Proposed Water Quality Objectives, Numeric Targets) describes two proposed water quality objectives to protect aquatic life and wildlife, how they protect human health, and the rationale for vacating the 4-day average objective; the targets are equal to the proposed water quality objectives. Section 7 (Linkage Analysis) describes the conceptual model of mercury in the watershed, that is, the relationship between mercury sources and the proposed targets.

Sections 8 through 10 provide the key regulatory analyses. Section 8 (TMDLs and Allocations) proposes allocations for mercury sources and describes the margin of safety afforded by the analysis. Section 9 (Implementation and Monitoring) proposes mercury pollution prevention and control actions necessary to reach the targets, describes monitoring to evaluate TMDL progress, and describes how new information will be considered as it becomes available. Section 10 (Regulatory Analysis) includes the required State analyses pertaining to the establishment of new water quality objectives.

Lastly, Section 11 (References) lists information sources cited and relied upon to prepare this report, and Appendices A, B, and C provide data, supporting calculations, and figures relied upon to prepare this report.

## 1.3 Changes from February 2008 Report

This September 2008 final *Staff Report* has been revised in response to comments on the February 2008 *Staff Report for Public Comment*. We present a summary of the changes in Table 1.1. We revised the February 2008 proposed Basin Plan amendment accordingly.

**Table 1.1 Summary of Changes to Staff Report since February 2008**

| **Section No. & Title (Feb. 2008)** | **Summary of Changes to Staff Report from February 2008 *Staff Report for Public Comment* to September 2008 final *Staff Report*** |
|---|---|
| 2.2 Project Objectives | We added a project objective relating to the beneficial uses for the Guadalupe River. |
| 2.4 Impaired Waters and Applicable Water Quality Standards | We clarified that this TMDL project addresses seven waters "impaired" by mercury, and assigns allocations to many other waters that either drain historic mercury mines or convey urban stormwater runoff. |
| 3.4 Mining Operations | *Definition of New Almaden Mining District for TMDL* slightly revised to refer separately to Guadalupe mercury mine. *Smaller, Less Productive Mercury Mines* revised to explain that Hillsdale mercury mine does not drain to Canoas Creek (or any waters in Guadalupe River watershed). Consequently, we removed Hillsdale mercury mine from the Guadalupe River watershed mercury TMDL project, although it is still subject to the same erosion control requirements of the San Francisco Bay mercury TMDL. |
| 5. Proposed Water Quality Objectives, and 6. Numeric Targets | We clarified that both the objectives and targets apply to trophic level 3 fish, and the 0.1 mg/kg objective and target is for fish larger than 15 centimeters (>15–35 cm). |
| 7.1 Qualitative Linkage from Sources to Targets | We rearranged this section to focus on the strongest linkage between sources and targets, namely, methylmercury production in reservoirs.. |
| 7.6 Mercury in the Reference Reservoir | We edited this section for clarity. |
| 7 Key Points | We corrected errors in the key points. |
| 8. Allocations and TMDLs | We made substantial revisions to the mercury mining waste allocations in Section 8.1. We moved the text regarding TMDLs from page 8-1 to a new section, 8.6 Total Maximum Daily Loads (TMDLs). We clarified the seven waters for which we established TMDLs, assimilative capacity, moved the margin of safety and seasonal variations to Section 8.6, and added daily load expressions. We clarified that both the urban and non-urban stormwater runoff allocations apply to segments of Los Gatos Creek upstream of Vasona Dam. |
| 9. Implementation and Monitoring | We added a summary table of the implementation and monitoring plan to the beginning of Section 9 (Table 9-1). We listed the responsible parties on Table 9-1, and in Section 9-1. We clarified our strategy to address Alamitos Creek in Section 9.5. |
| 10. Regulatory Analyses | We slightly revised the analyses required by the California Environmental Quality Act in Sections 10.3–10.5. |
| 11. References | References have been added, where necessary, for changes described above. |
| Appendix A. | We added Table A.10, *Fish Mercury Concentrations in Almaden Reservoir and Lake Almaden* |

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# 2. Project Definition

This section presents the project definition and objectives which form the basis of the assessment required by CEQA. It also presents the problem statement upon which the proposed Basin Plan amendment project is based, impaired waters, and applicable water quality standards.

## 2.1 Project Definition

The proposed project is a Basin Plan amendment to establish fish tissue water quality objectives and Total Maximum Daily Loads (TMDLs) for mercury in certain waters of the Guadalupe River Watershed (see Section 1) and an implementation plan to achieve the TMDLs. The goal of the Basin Plan amendment is to improve environmental conditions by addressing mercury pollution in the Guadalupe River watershed and San Francisco Bay and to reduce mercury fish tissue concentrations. The Basin Plan amendment would include targets for small prey fish tissue methylmercury concentrations, and would establish allocations for mercury in sediment and methylmercury in the water column necessary to achieve the targets. The Basin Plan amendment implementation plan would require actions to achieve the targets and allocations for mercury and methylmercury.

## 2.2 Project Objectives

The proposed Basin Plan Amendment is intended to reduce existing and future mercury discharges to, and methylmercury production in, waters of the Guadalupe River watershed and San Francisco Bay. Specific objectives of the project are as follows:

- *Revise mercury water quality objectives to reflect current scientific information and the latest U.S. EPA and U.S. Fish and Wildlife Service guidance*
- *Restore and protect beneficial uses in waters of the Guadalupe River watershed by attaining TMDL numeric targets and water quality standards while maintaining—enhancing where possible—habitat for wildlife*
- *Restore and protect downstream beneficial uses by reducing mercury discharges to San Francisco Bay from legacy and urban stormwater runoff sources*
- *Favor implementation actions with multiple benefits; phase implementation to control upstream sources before downstream sources are addressed and while methylmercury controls are being developed*
- *Implement effective source control measures for mining waste at mine sites and in downstream depositional areas*
- *Complete studies of methylmercury and bioaccumulation controls in reservoirs and lakes, and implement effective controls*
- *Achieve the legacy mercury and urban stormwater runoff mercury load allocations assigned to the Guadalupe River watershed by the San Francisco Bay mercury TMDL*

- *Avoid imposing regulatory requirements that are more stringent than necessary to meet numeric targets and attain water quality standards; Avoid actions that will have unreasonable costs relative to their environmental benefits*
- *Comply with the Clean Water Act requirements to adopt TMDLs for 303(d) listed water bodies and comply with the State Water Board's directive to integrate the Bay and Guadalupe mercury TMDLs*
- *Consider site-specific factors relating to mercury sources and methylmercury production, ambient conditions, watershed characteristics, and response to management actions; Avoid arbitrary decisions and speculation when computing loads, setting targets, setting allocations, determining implementation actions, and defining a margin of safety*
- *Establish allocations based on the goals of (a) eliminating inputs of mercury caused by anthropogenic activities, particularly mining and urban stormwater runoff, and (b) minimizing the transformation of mercury to methylmercury caused by anthropogenic activities, particularly the construction and operation of reservoirs, lakes and shallow impoundments*
- *Provide details of an implementation plan that includes: a description of the nature of actions necessary to meet allocations and targets and thereby achieve water quality standards; a schedule for actions to be taken; and a description of monitoring to be undertaken to determine progress toward meeting allocations, targets and water quality objectives*
- *Attain the TMDL targets in as short a time as feasible, and no longer than 20 years*
- *Base decisions on readily available information on ambient conditions, loads, fish consumption patterns, and fate and effects; Establish a decision-making framework where management actions adapt to future knowledge or conditions*
- *Correct an error made during the 2005 Basin Planning process, in which the reference to the Guadalupe River was inadvertently removed and replaced with a reference to the Guadalupe Reservoir in Table 2-1, Existing and Potential Beneficial Uses of Water Bodies in the San Francisco Bay Region. Include the Guadalupe River's beneficial uses, as shown in the 1986 Basin Plan: Cold Freshwater Habitat (COLD), Fish Migration (MIGR) (potential), Fish Spawning (SPWN) (potential), Warm Freshwater Habitat (WARM), Wildlife Habitat (WILD), Water Contact Recreation (REC1) (potential); and Noncontact Water Recreation (REC2).*

## 2.3 Problem Statement

The New Almaden Mining District (see Figure 1.2) was the largest-producing mercury mine in North America. Typical of the time, waste management practices largely consisted of dumping roasted ores (calcines) into creeks for large winter storms to wash downstream. Consequently, fish downstream of the mining district have extremely high mercury concentrations and are unsafe to eat. Fish from Guadalupe Reservoir contain the highest recorded fish tissue mercury concentrations in California.

### *Fish Consumption and Human Health*

In humans, the principal route for mercury exposure is through the consumption of mercury-containing fish (USEPA 2001). The California Toxics Substances Monitoring Program collected about 100 fish from the watershed in 1986 (TSMP 1978-2000). Seventy percent of these samples exceeded the U.S. Food and Drug Administration’s (USFDA) action level of 1 mg/kg mercury in fish tissue. To protect human health, in 1987 Santa Clara County issued a fish consumption advisory to not consume any fish from Guadalupe, Almaden, and Calero reservoirs; Alamitos and Guadalupe creeks; Guadalupe River; and percolation ponds on these creeks and river. In 1988, the 303(d) list of impaired waters was first released, and these water bodies were included. In January 2001, USEPA issued a methylmercury criterion in fish tissue for the protection of human health of 0.3 mg/kg (more stringent than the USFDA action level).

In humans, mercury is neurotoxic, affecting the brain and spinal cord, and interfering with nerve function. Pregnant women and nursing mothers can pass mercury to their fetuses and infants through the placenta and breast milk. In children, particularly those under age six, mercury can decrease brain size, delay physical development, impair mental abilities, cause abnormal muscle tone, and result in coordination problems. Substantial mercury exposure is also associated with birth defects and infant mortality. Adults exposed to mercury may experience abnormal sensations in their hands and feet, tiredness, or blurred vision. Higher levels of mercury exposure can impair hearing and speech. Long-term exposure can damage the kidneys (D’Itri 1991; Davies 1991; COEHHA 1997; USDHHS 1999; USEPA 1997c). In summary, the main human health concern is for the fetus and young children.

Results of fish samples collected from throughout the Guadalupe River watershed in 2004 are shown on Figure 2.1. The adult largemouth bass were about 40 centimeters (cm) in length, which is believed to be representative of the size consumed by humans. (See Section 5 for how we propose to protect human health from mercury in fish.) Mercury concentrations in adult largemouth bass were greatest in Guadalupe and Almaden reservoirs located immediately downstream of the mining district, and were still elevated in Almaden Lake and Calero Reservoir, which are farther downstream. In contrast, adult largemouth bass in Lexington Reservoir, which does not receive mining waste or urban runoff, have much lower concentrations of mercury.

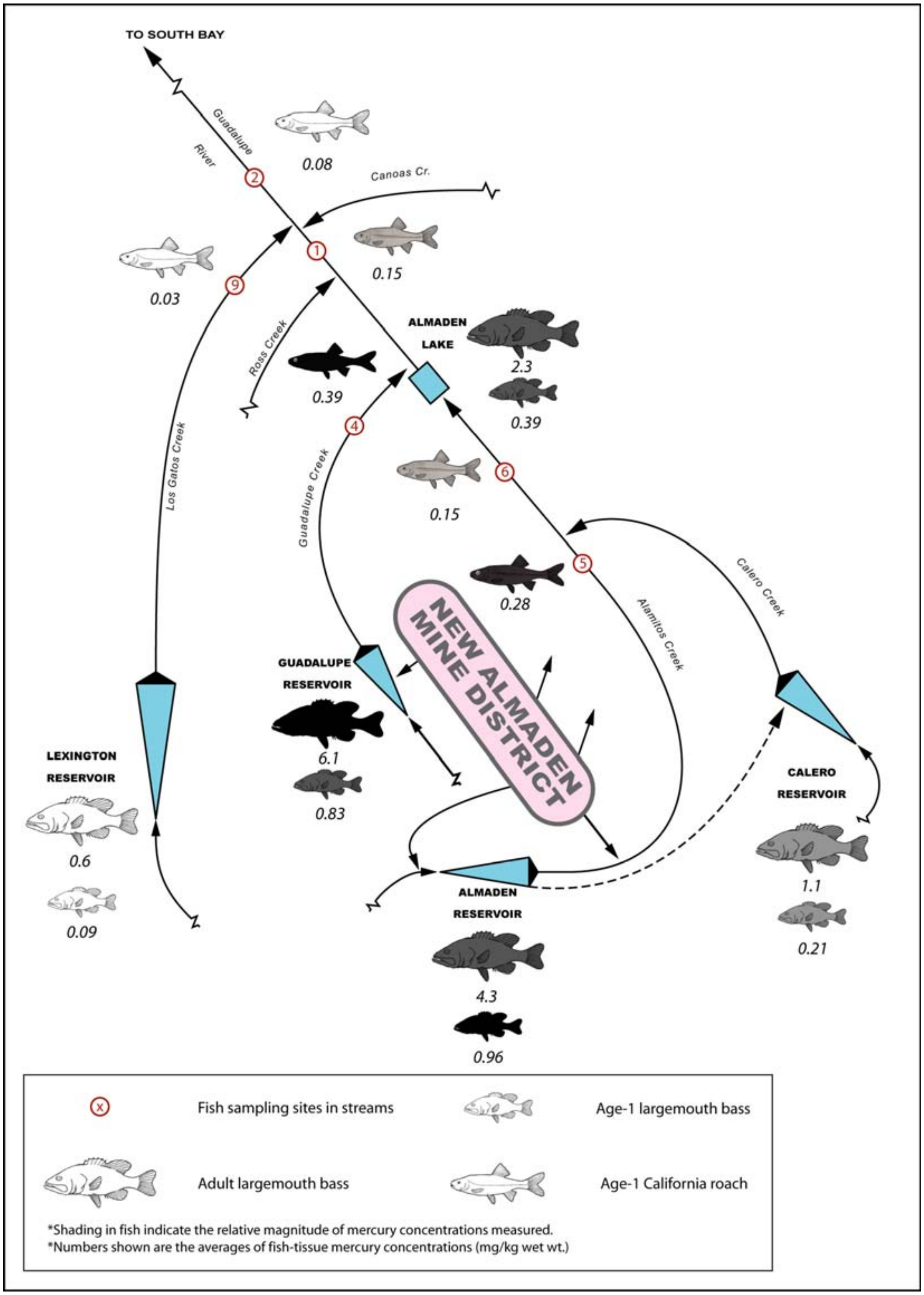


**Figure 2.1 Summary of 2004 Fish Sampling Results**

*Citation: Figure 3-25 Final Conceptual Model Report (Tetra Tech 2005c)*

Darker fish indicate higher mercury concentrations. This schematic makes it clear that fish closest to New Almaden have higher mercury concentrations. Guadalupe Reservoir has the highest recorded fish mercury concentrations in California.

The adult largemouth bass were about 40 centimeters (cm) in length, which is believed to be representative of the size consumed by humans. (There are no fish consumption surveys for this or similar and nearby watersheds that could provide fish consumption information.) In Figure 2.2 (see Table A.1 in Appendix A for data and references) we present three decades of fish mercury data from Guadalupe Reservoir, which shows that mercury in fish has been, and remains, elevated.

Table 2.1 compares data for mercury in largemouth bass collected from Guadalupe, Almaden, and Calero reservoirs, and Almaden Lake (all downstream of the New Almaden Mining District), to mercury concentrations in similar fish collected from the San Francisco Bay area. Although largemouth bass from many water bodies have elevated mercury concentrations, Table 2.1 clearly shows that the mercury concentrations for largemouth bass are higher in Guadalupe Reservoir, Almaden Reservoir, and Lake Almaden as compared to fish collected from other water bodies in the San Francisco Bay area.

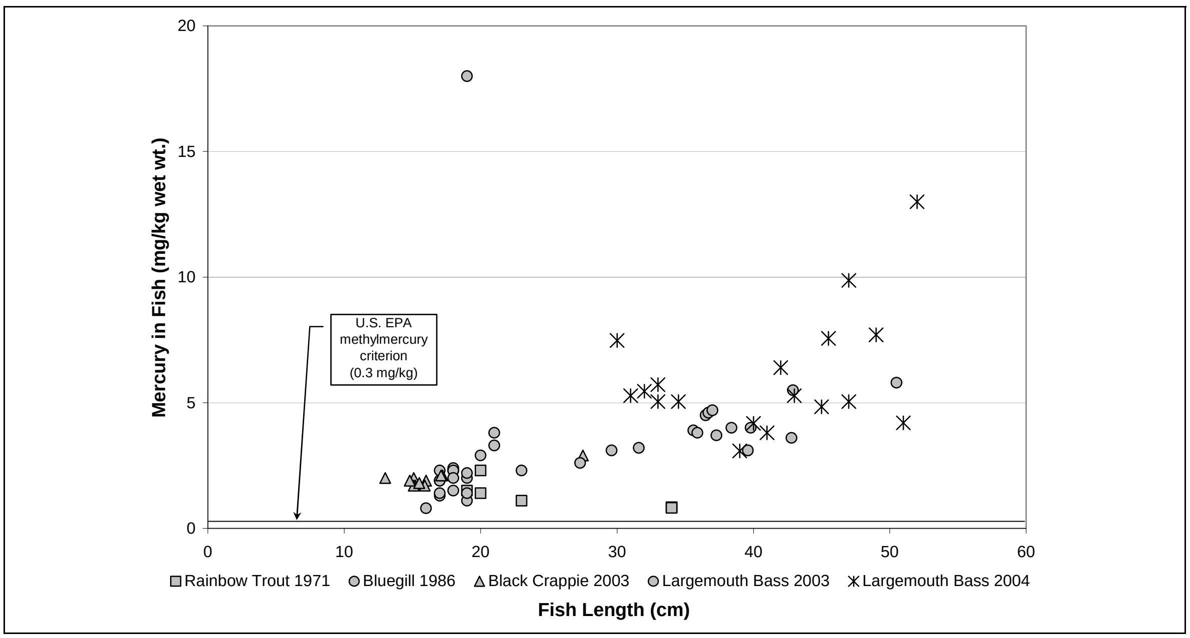


**Figure 2.2 Guadalupe Reservoir Fish 1971–2004**

Mercury in fish has remained elevated over the past three decades.

**Table 2.1 Mercury in Fish from San Francisco Bay Area**

*Citation: Table 8-3, Data Collection Report (Tetra Tech 2005a)*

| Water Body Downstream of New Almaden Mining District | Other Water Bodies in San Francisco Bay Area (only Soulajule Reservoir is affected by mercury mines) | Mercury Standardized 40 cm Largemouth Bass (mg/kg, wet weight) |
|---|---|---|
| Guadalupe Reservoir | | 5.8 |
| Almaden Reservoir | | 3.6 |
| Lake Almaden | | 2.1 |
| | Stevens Creek Reservoir, Stevens Creek watershed, Santa Clara County | 1.4 |
| | Anderson Reservoir, Coyote Creek watershed, Santa Clara County | 1.3 |
| Calero Reservoir | | 1.2 |
| | **Soulajule Reservoir, Marin County** | **1.1** |
| | Del Valle Reservoir, Alameda County | 0.9 |
| | Nicasio Reservoir, Marin County | 0.8 |
| | Lexington Reservoir, Guadalupe River watershed, Santa Clara County | 0.6 |
| | Lake Chabot, Alameda County | 0.6 |
| | Lafayette Reservoir, Contra Costa County | 0.4 |

### *Fish Consumption and Wildlife*

Mercury poses potential hazards to birds, mammals, and other wildlife. Birds and mammals that consume fish and other aquatic organisms can be exposed to significant quantities of mercury. In birds, mercury can adversely affect survival. It can affect cell development and reproductive success, and cause developmental problems in the young. It can cause reduced feeding, weight loss, lack of coordination, hyperactivity and hypoactivity, and liver and kidney damage. In mammals, mercury can reduce speed and agility, making it more difficult to obtain food and avoid predation (USEPA 1997d). The embryos of birds and other vertebrates are more sensitive to mercury exposure than adults (Wiener et al. 2003).

As in humans, the principal route for mercury exposure in wildlife is through the consumption of mercury-containing fish (USFWS 2005). Fish of smaller sizes, typical of wildlife consumption, were sampled throughout the watershed, and results are shown in Table 2.2 and Figure 2.1. The age-1 largemouth bass, about 9 cm in length, were collected from reservoirs and Almaden Lake. Like the adult largemouth bass, mercury concentrations in age-1 largemouth bass were greatest in Guadalupe and Almaden reservoirs located immediately downstream of the mining district and were still elevated in Almaden Lake and Calero Reservoir, which are farther downstream. The lowest mercury concentrations in age-1 largemouth bass were in Lexington Reservoir.

The age-1 California roach, about 50 cm in length (SCVWD 2005), were collected from several creeks and the Guadalupe River. Like the largemouth bass, mercury concentrations in age-1 California roach were greatest in the water bodies closest to the mining district, Guadalupe and Alamitos creeks, and were elevated in the Guadalupe River. Samples were collected from two locations in both Alamitos Creek and the Guadalupe River. In both cases, the upstream samples had higher mercury concentrations than the downstream samples. The lowest mercury concentrations in age-1 California roach were found in Los Gatos Creek at a downstream location that receives urban runoff, but like all locations in this sub-watershed, does not receive mining waste.

**Table 2.2 Mercury in Age-1 Fish**

*Citations: Figure 8-5, Tables 8-4 and 8-5, Data Collection Report (Tetra Tech 2005a)*

| **Water Body Downstream of New Almaden Mining District** | **Largemouth Bass Average Mercury (mg/kg, wet weight)** | **California Roach Average Mercury (mg/kg, wet weight)** |
|---|---|---|
| Guadalupe Reservoir | 0.83 | |
| Guadalupe Creek | | 0.39 |
| Almaden Reservoir | 0.39 | |
| Alamitos Creek (Site 5) | | 0.28 |
| Alamitos Creek (Site 6) | | 0.15 |
| Almaden Lake | 0.96 | |
| Guadalupe River (Site 2) | | 0.15 |
| Guadalupe River (Site 1) | | 0.08 |
| Calero Reservoir | 0.21 | |
| Water Body Outside of New Almaden Mining District | Largemouth Bass Average Mercury (mg/kg, wet weight) | California Roach Average Mercury (mg/kg, wet weight) |
| Lexington Reservoir | 0.09 | |
| Los Gatos Creek | | 0.03 |

### *2.4 Impaired Waters and Applicable Water Quality Standards*

The seven waters impaired by mercury and addressed by this TMDL project are the following:

- Guadalupe Reservoir, Almaden Reservoir, Calero Reservoir, and Lake Almaden
- Guadalupe Creek, Alamitos Creek, and Guadalupe River

This TMDL project addresses five waters already listed as impaired by mercury and two that will be proposed for listing in the next cycle (2008 303(d) list). As explained in Section 2.3, to protect human health Santa Clara County issued a fish consumption advisory to not consume any fish from Guadalupe, Almaden, and Calero reservoirs; Alamitos and Guadalupe creeks; Guadalupe River; and percolation ponds on these creeks and river. Based on this health advisory, the following five waters were listed in 1998 as impaired by mercury in the Guadalupe River watershed (Figure 1-2) under CWA Section 303(d): Alamitos Creek, Calero Reservoir, Guadalupe Reservoir, Guadalupe Creek, and the Guadalupe River.

Staff will recommend listing both Almaden Reservoir and Lake Almaden in the next 303(d) listing cycle (2008). Highly elevated mercury concentrations are found in fish in both of these waters (Figure 2.1). Table A.10 in Appendix A presents mercury concentrations in skinless fish filet samples from Almaden Reservoir and Lake Almaden. All but two of these 66 samples exceed the U.S. EPA criterion for the protection of human health of 0.3 milligrams of methylmercury per kilogram of fish tissue (mg/kg). This level of exceedance satisfies the requirements of the 303(d) listing policy to list these waters as impaired (SWRCB 2004).

This TMDL project includes waters “impaired” by mercury, creeks that drain mercury mines, and waters that convey urban stormwater runoff. All waters drain eventually to Guadalupe River, which is impaired. (Table 2.3 provides a summary of waters addressed by this TMDL project, and whether they are impaired, drain creeks, or convey urban stormwater runoff. Table 8.6 describes which waters are assigned allocations, TMDLs, and/or new fish tissue water quality objectives.)

We do not propose to formally list waters, not already on the 303(d) list, that drain mercury mines or convey urban stormwater runoff as impaired. In 2004, the State adopted a guidance policy for placing waters on the 303(d) list (SWRCB 2004). This policy has very rigorous data sufficiency requirements, and there are not data of sufficient quality and quantity to list every segment of every waterbody that drains mercury mines or conveys urban stormwater runoff. The creeks that drain mercury mines and convey urban stormwater runoff are all tributaries to, or segments of, one or more of the impaired waters. The seven impaired waters extend continuously from the highest watershed reaches that drain mercury mines, the highest reaches that receive urban stormwater runoff, to reservoirs and lakes, and down to the bottom of this watershed where Guadalupe River meets the Bay. Therefore, these seven waters adequately characterize impaired waters in the portion of the watershed addressed by this TMDL project. We believe that the efforts of all parties are better spent on solving the mercury problem, than on sampling efforts to generate sufficient data to list each and every segment individually.

Additionally, this TMDL project includes many waters that drain from non-mine (i.e., non-mineralized) and non-urban portions of the upper watershed. Allocations are assigned to these waters because they are a source of mercury to impaired waters, albeit small loads. These waters are too numerous to list, but examples include Barrett Canyon (drains Loma Prieta into Alamitos Creek at Almaden Reservoir), upper Guadalupe Creek and Rincon Creek (drain Mt. Umunhum into Guadalupe Creek), and Los Gatos Creek above Lexington Dam.

Lexington Reservoir receives mercury from atmospheric deposition and naturally occurring mercury in soil, but it is not affected by mercury mining. We plan to address mercury impacts to Lexington Reservoir (and to Los Gatos Creek and its tributaries upstream of Vasona Dam, including Vasona Lake, Lexington Reservoir, and Lake Elsman) in a future TMDL project for San Francisco Bay Area reservoirs unaffected by mercury mining. Consequently, the proposed fish tissue water quality objectives and the implementation plan do not apply to Los Gatos Creek and its tributaries upstream of Vasona Dam, including Vasona Lake, Lexington Reservoir, and Lake Elsman (see Figure 1.2). Table 2.3 provides a summary of waters addressed by this TMDL project.

## Table 2.3 List of Waters Addressed by this TMDL Project

| Waters | Mercury Sources: Mercury Mine | Mercury Sources: Urban Stormwater Runoff | Mercury Sources: Soil | Impaired 303(d)-listed | Creeks: drain mercury mines | Creeks: convey urban stormwater runoff |
|---|---|---|---|---|---|---|
| Guadalupe Creek & percolation ponds | X | O | | ✓ | | |
| Tributaries from New Almaden | X | | | | ✓ | |
| Upper watershed non-urban non-mined tributaries | | | X | | | |
| Tributaries from urban non-mined areas | | X | | | | ✓ |
| Guadalupe Reservoir | X | | | ✓ | | |
| Alamitos Creek & percolation ponds | X | O | | ✓ | | |
| Tributaries from New Almaden | X | O | | | ✓ | |
| Upper watershed non-urban non-mined tributaries | | | X | | | |
| Tributaries from urban non-mined areas | | X | | | | ✓ |
| Almaden Reservoir | X | | | ✓ | | |
| Lake Almaden | X | O | | ✓ | | |
| Calero Reservoir | X | | | ✓ | | |
| Calero Creek | X | O | | | ✓ | |
| Canoas Creek | X | O | | | ✓ | |
| Ross Creek | | X | | | | ✓ |
| Los Gatos Creek & tributaries upstream of Lenihan Dam | | X | | | | |
| Los Gatos Creek & tributaries downstream of Lenihan Dam & percolation ponds | | X | | | | ✓ |
| Guadalupe River & percolation ponds | X | O | | ✓ | | |

Notes:
X = Primary mercury source (soil includes atmospheric deposition)
O = Some segments of these waters receive mercury from this source
✓ = Primary consideration

Table 8.5 describes which waters are assigned allocations, TMDLs, and/or new water quality objectives.

### *Applicable Water Quality Standards*

The water quality standards for waters in the Guadalupe River watershed include beneficial uses, narrative water quality objectives, numeric water quality objectives, and antidegradation provisions. The beneficial uses of waters in the watershed include: Cold Freshwater Habitat (COLD); Freshwater Replenishment (FRSH); Groundwater Recharge (GWR); Fish Migration (MIGR); Municipal and Domestic Supply (MUN); Preservation of Rare and Endangered Species (RARE); Water Contact Recreation (REC1); Noncontact Water Recreation (REC2); Fish Spawning (SPWN); Warm Freshwater Habitat (WARM); and Wildlife Habitat (WILD). Of the many beneficial uses listed above, only human consumption of fish (REC1) and wildlife consumption of fish (RARE and WILD) are impaired by mercury.

The Basin Plan mercury water quality objectives include narrative objectives for bioaccumulation and toxicity. They also include the following numeric water quality objectives: for municipal supply (Table 3-5 of the Basin Plan), 2,000 nanograms of mercury per liter of water (ng/l, parts per trillion); and for toxic pollutants (Table 3-4), 25 ng/l four-day average and 2,400 ng/l one-hour average. In addition, the California Toxics Rule (Code of Federal Regulations, Title 40, §131.38) limits mercury in surface water to 50 ng/l 30-day average.

The U.S. Environmental Protection Agency (USEPA) has published a methylmercury criterion of 0.3 milligrams methylmercury per kilogram of fish tissue (mg/kg, parts per million) (USEPA 2001). This criterion, while not yet formally adopted for California, is also considered in setting TMDL targets and objectives.

The current water quality objectives applicable to waters impaired by mercury in the Guadalupe River watershed are the Basin Plan narrative objective for bioaccumulation, Basin Plan numeric water quality objectives for toxic pollutants (both 25 ng/l 4-day and 2,400 ng/l 1-hour), and the California Toxics Rule (50 ng/l 30-day). The Basin Plan numeric objectives are based on the USEPA *Ambient Water Quality Criteria for Mercury –1984* (USEPA 1985). The Basin Plan bioaccumulation objective states:

> Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.

***Key Points***

- The waters addressed by this TMDL are downstream of mercury mines and/or receive urban runoff—the waters of the Guadalupe River watershed except Los Gatos Creek and its tributaries upstream of Vasona Dam, including Vasona Lake, Lexington Reservoir, and Lake Elsman (see Figure 1.2).
- Of the many beneficial uses, only human consumption of fish (REC1) and wildlife consumption of fish (RARE and WILD) are impaired by mercury.
- The existing mercury water quality objectives in the Guadalupe River watershed are the Basin Plan narrative objective for bioaccumulation and numeric water quality objectives for toxic pollutants (both 25 ng/l 4-day and 2,400 ng/l 1-hour), and the California Toxics Rule (50 ng/l 30-day).
- The main environmental concern with mercury in this watershed is mercury in fish. To protect human health, in 1987 Santa Clara County issued a fish consumption advisory to not consume any fish from Guadalupe, Almaden, and Calero reservoirs; Alamitos and Guadalupe creeks; Guadalupe River; and percolation ponds on these creeks and river (i.e., water bodies containing mining wastes).
- Mercury concentrations in fish samples collected in 2004 were greatest in Guadalupe and Almaden reservoirs located immediately downstream of the mining district. In contrast, adult largemouth bass in Lexington Reservoir, which does not receive mining waste or urban stormwater runoff, have much lower concentrations of mercury.

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# 3. BACKGROUND

California's New Almaden Mining District was one of the largest mercury producers in the world, accounting for about 5 percent of the world's mercury production (Table 3.1). Only four other mines extracted more mercury than this historic South San Francisco Bay district, top among these being the Almaden mine in Spain.

New Almaden mined one of 51 major mercury deposits in the 400 km mineral belt extending up and down California's Coast Range (mercury mines are indicated in red on Figure 3.1). Each of these 51 deposits was large enough to have produced in excess of 1,000 flasks of mercury (a flask equals 76 pounds or 34 kg). The two largest producers were the New Almaden Mining District in the hills above the city of San Jose and New Idria near Coalinga on the southwest hillsides of the Central Valley. Numerous smaller deposits with elevated concentrations of mercury are also present in the mineral belt.

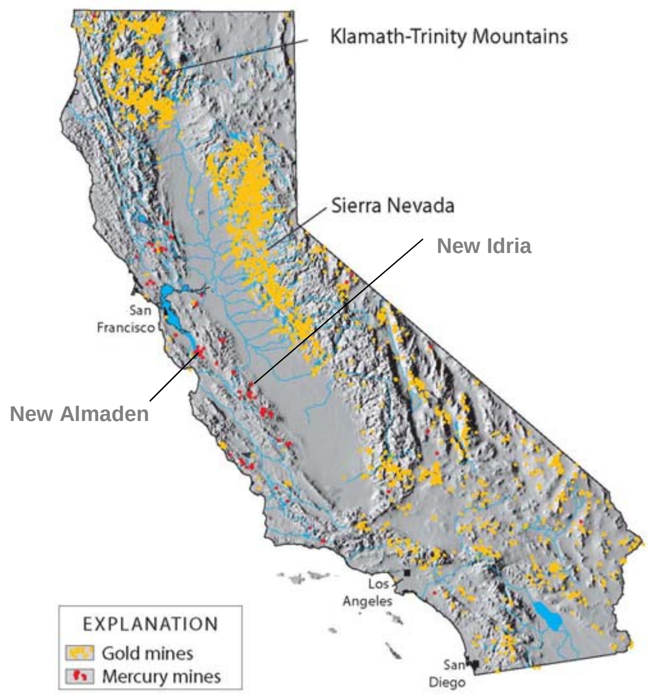



**Figure 3.1 Historic Gold and Mercury Mines in California**

*Citation: USGS Fact Sheet 2005-3014 Version 1.1 Revised October 2005*

Locations of former mercury mines in California's Coast Range are indicated in red. New Almaden was the largest supplier of mercury to the gold mines, which are indicated in gold.

Due to the size of this mining district and the complexity of mercury in the environment (described in Section 7, Linkage), the New Almaden Mining District warrants detailed study and a conceptual model of mercury behavior in the Guadalupe River watershed.

**Table 3.1 World Production of Mercury**

*Citation: (Cox 2000)*

| | **Mercury Produced** (million kilograms) | **Percent of World Production** |
|---|---|---|
| Almaden, Spain | 271 | 33% |
| Rest of World | 188 | 22% |
| Monte Amiata, Italy | 104 | 12% |
| Idria, Yugoslavia (Slovenia) | 102 | 12% |
| Rest of U.S. | 64 | 8% |
| Huancavelica, Peru | 52 | 6% |
| New Almaden, U.S. | 38 | 5% |
| New Idria, U.S. | 20 | 2% |
| Total | 839 | 100% |

## *3.1 Preliminary Studies and Data Collection*

#### *PRELIMINARY STUDIES*

In 1999, the Guadalupe Mercury Work Group was convened by the Santa Clara Basin Watershed Management Initiative (WMI), partly to assist with the technical basis of this TMDL. It was co-chaired by Water Board and Santa Clara Valley Water District (Water District) staff, and its membership included watershed residents, representatives from USEPA, environmental advocacy organizations, and local agencies.

In 2000, the Guadalupe Mercury Work Group produced two preliminary documents:

1) *Work Plan to Develop and Implement a Total Maximum Daily Load (TMDL) For Waterbodies in the Guadalupe River Watershed Listed as Impaired Due to Mercury*, dated June 29, 2000 (the TMDL Work Plan); and,

2) *Guadalupe River Mercury TMDL Workgroup's Recommended Interim Sampling and Monitoring Plan*, dated December 7, 2000 (the Sampling Plan).

These documents provided the justification for securing a technical consultant. But first, the Guadalupe Mercury Work Group had to identify a source of funding for the technical consultant. In November 2000, the voters of Santa Clara County approved a ballot measure that created a special countywide 15-year parcel tax to fund the Clean, Safe Creeks and Natural Flood Protection Program, which is being implemented by the Water District. This bond measure includes $1 million per year for impaired water bodies. One year's funding was used for data collection and development of the conceptual model of mercury behavior in the Guadalupe River watershed. USEPA contributed reservoir fish sampling, the Water District contributed creek and river fish sampling, and USGS collected phyto- and zooplankton samples.

The consultant selected and tasked with conducting much of this data collection and developing the conceptual model was Tetra Tech, Inc. (Tetra Tech). The Guadalupe Mercury Work Group reviewed Tetra Tech's draft sampling plan, reports, and conceptual model. A Technical Review Committee of recognized mercury experts was also convened to review key draft documents that included Dr. Gary A. Gill from Texas A&M University at Galveston, Dr. Donald B. Porcella from Environmental Science and Management, Dr. James Rytuba from the U.S. Geological Survey, and Dr. James G. Wiener from the University of Wisconsin-La Crosse.

The following is an overview of some of the key documents reviewed by either the Guadalupe Mercury Working Group or the Technical Review Committee. Each document—the problem statement, surveys, sampling plan, and data collection report—was a step toward developing the *Final Conceptual Model Report* of mercury behavior in the Guadalupe River watershed.

#### *PRELIMINARY PROBLEM STATEMENT*

The *Preliminary Problem Statement* (Tetra Tech 2003a) was an important first step in the development of the Guadalupe River Watershed Mercury TMDL. This document provides a concise description of the current understanding of the processes or factors that are most relevant to controlling mercury in the watershed.

#### *SYNOPTIC SURVEY*

The *Synoptic Survey* (the Survey, Tetra Tech 2003b) was designed to meet two primary objectives. The first Survey objective was to provide a general overview of mercury contamination in the Guadalupe watershed. To accomplish this objective, the Survey included mercury and water quality sampling and chemical analyses at 24 spatially distinct locations, using consistent sample collection and analytical method protocols. The second Survey objective was aimed at identifying where the transformation of solid phase mercury to bio-available mercury occurs within the waters of the Guadalupe watershed.

The Survey includes preliminary mercury load estimates and extensive documentation on the locations of mining wastes in and downstream of the New Almaden Mining District. The Survey found that (1) Alamitos Creek warranted additional field mapping of mining wastes, and, (2) mercury is methylated, making it more bio-available, in reservoirs and other deep water impoundments.

The mining waste survey findings are discussed below in Section 3.3 (Principal New Almaden Mines). Together with the *Preliminary Problem Statement*, these findings were used to develop hypotheses for the Data Collection Plan.

#### *ALAMITOS CREEK SURVEY*

With the continent's largest mercury mine and a furnace yard on its banks, Alamitos Creek probably has the most mercury mining waste of any creek in California and warranted its own survey. Most of the ore from Mine Hill, New Almaden's largest mine, was processed at the Hacienda Furnace Yard on Alamitos Creek just above the confluence with Deep Gulch Creek (see Figure 3.7). Waste disposal practices largely consisted of piling the roasted ore (calcines) into creeks for winter rains to wash downstream. The findings are discussed below in Section 3.3 (Principal New Almaden

Mines). The *Survey of Alamitos Creek from McKean Road to Almaden Reservoir* (Tetra Tech 2003c) provides extensive written and photographic documentation of mining wastes in Alamitos Creek.

#### DATA COLLECTION PLAN AND REPORT

The Data Collection Plan (i.e., Sampling Plan, Tetra Tech 2004a) for the Guadalupe River watershed had two primary objectives. The first was to identify those data that are essential for development of a TMDL for mercury in the Guadalupe River watershed. Each data requirement was discussed in terms of its use in the preparation of the TMDL and its contribution to the reduction of uncertainty in our understanding of the biogeochemical processes controlling mercury transport, fate, and bioavailability in the Guadalupe River watershed. The second objective was to develop and describe an efficient sampling plan for collection of these data. The Sampling Plan described the objectives for each major sampling task, including hypotheses, the parameters to be measured, and described the overall sampling approach.

During the 2003-2004 wet season and 2004 dry seasons, Tetra Tech conducted sampling (i.e., data collection) in the Guadalupe Watershed. The sampling yielded estimates of wet season mercury loads, provided fish tissue mercury concentration data for fish collected from impoundments (i.e., slow-moving water bodies that form behind engineered structures such as dam; see Section 8.2 for the definition of impoundments used in this TMDL), creeks, and the Guadalupe River, and revealed that high rates of methylmercury production occur in Guadalupe and Almaden reservoirs during the dry season (Tetra Tech 2005a).

The sampling results and findings formed the basis of the conceptual model and now provide the scientific basis for this TMDL and staff report. The Source Analysis and Linkage (Sections 4 and 7 herein) largely excerpt information from the *Data Collection Report* (as refined by the *Final Conceptual Model Report).*

## *3.2 Final Conceptual Model*

The preliminary problem statement, field surveys, sampling plan, and data collection phases were each steps toward developing the *Final Conceptual Model Report* (the Final Conceptual Model Report) of mercury behavior in the Guadalupe River watershed (Tetra Tech 2005c.) The Final Conceptual Model Report includes:

- Watershed characterization—a general description of the watershed;
- Data summary—a succinct presentation of the data collection findings;
- Estimated mercury loads—these form the TMDL source analysis (Section 4 herein); and,
- Conceptual model of mercury behavior in the Guadalupe River watershed—this model serves as the basis for our Linkage Analysis (Section 7).

The Final Conceptual Model Report was completed under contract to the Water Board. Due to budget, the earlier, *Draft Final Conceptual Model Report*, was not submitted to the Technical Review Committee for review. Therefore, the Water Board circulated the *Final Conceptual Model Report* for public review and comment concurrently with the January 2006 staff report (SFBRWQCB 2006). Comments were considered and are reflected in this TMDL staff report.

## 3.3 Watershed Description and System Characteristics

#### TOPOGRAPHY

The headwaters of the Guadalupe River spring from the eastern Santa Cruz Mountains. The highest point in this watershed is Loma Prieta (elevation 3,790 feet, see Figure 3.2), which drains to both Los Gatos and Alamitos creeks (the latter via Barrett Canyon tributary). The Guadalupe River begins at the confluence of Alamitos and Guadalupe creeks, below Almaden Lake (the names Almaden Lake and Lake Almaden are used interchangeably in the watershed, on signage, and on maps), and flows 19 miles through heavily urbanized portions of San Jose, ultimately discharging into South San Francisco Bay through Alviso Slough (Figure 3.2). Three urban creeks—Ross, Canoas, and Los Gatos creeks—join the river as it flows toward San Francisco Bay. The Guadalupe River has a total drainage area of approximately 170 square miles south of Highway 237. Tides influence the lower reach of the river as it flows for five miles through Alviso Slough to San Francisco Bay. When development of the salt ponds in the South Bay began in 1866, lower river flows were diverted from their original course through Guadalupe Slough to Alviso Slough. There are no natural deep lakes in the watershed; all reservoirs and percolation ponds (i.e., former gravel quarries, including Almaden Lake) are engineered impoundments.

#### SUBWATERSHED DESCRIPTIVE TERMS

A number of key terms are used in this TMDL. The first term is “reference reservoir”, i.e., “reference site.” Scientists use reference sites, not affected by the particular influence being studied, to compare to affected sites. In this case, we compare a reference reservoir that is not affected by mercury mining to reservoirs affected by mercury mining. The reference reservoir is Lexington Reservoir, located along Los Gatos Creek, which is largely undeveloped in its headwaters (which includes two reservoirs, Lake Elsman and Lexington Reservoir) (Figure 3.2). Lexington Reservoir is readily accessible to the public (and for sampling), and due to the lack of mercury mining, was selected as the reference reservoir for the data collection and conceptual model development efforts.

A second key term, “background” areas, are not affected by mercury mining and include undeveloped and non-mining headwater areas for Calero, Alamitos, Guadalupe, and Los Gatos creeks. Lexington Reservoir (the reference reservoir) is located in the background area (Figure 3.2).

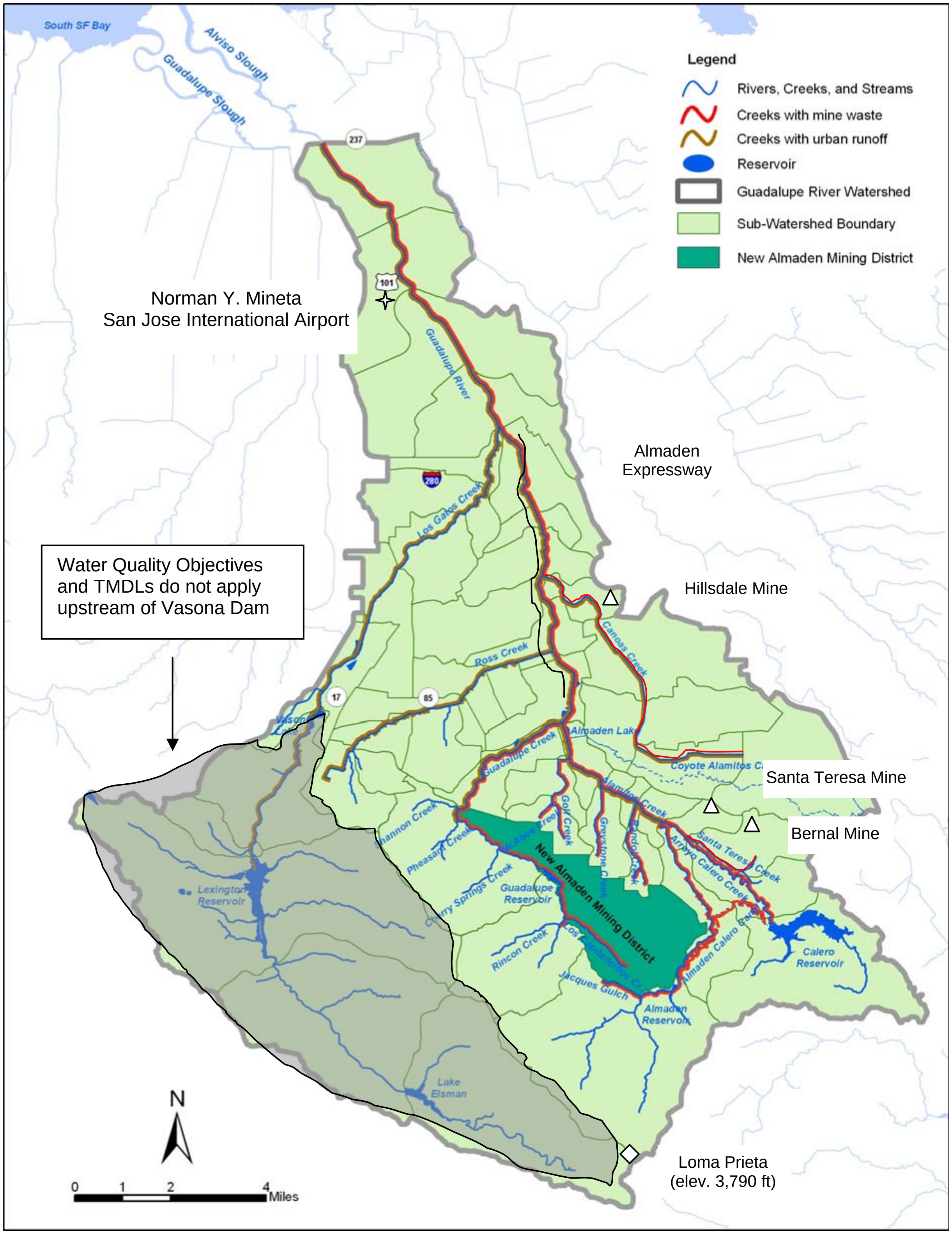



**Figure 3.2 Guadalupe River Watershed Major Water Bodies and Subwatersheds**

*Citation: Figure 2-2 in Final Conceptual Model Report (Tetra Tech 2005c)*

A third term, the “mining” area, refers to the mercury mining area. The mining area includes everything “in and downstream” of the New Almaden Mining District, and the Santa Teresa, Bernal, and Hillsdale mercury mines. The mining area extends through the Guadalupe River, which begins at the confluence of Alamitos and Guadalupe creeks, below Almaden Lake (see Figure 4.1—“mining district” in dark green and “creeks with mining waste” in red). The mining district drains to Guadalupe and Alamitos creeks both above and below the reservoirs on these creeks (Guadalupe and Almaden reservoirs).

A fourth term defines the “urban” area, refers to the large, lower extent of the watershed that contains cities. The urban area is distinct from the mining and background areas. The urban area includes the areas surrounding Los Gatos Creek below Lexington Reservoir, Ross and Canoas creeks, the lower portions of Guadalupe and Alamitos creeks, and the Guadalupe River (Figure 3.2).

#### *CLIMATE*

The Guadalupe River watershed experiences a Mediterranean-type climate generally characterized by wet, mild winters and dry summers. About 85 percent of the measurable precipitation, rainfall, occurs between November and April. Temperatures range from below freezing in the mountains for a few days in winter to nearly 100°F in the hottest parts of the valley in the summer. Mean annual precipitation ranges from 48 inches in the headwaters above the Guadalupe and Almaden reservoirs to 14 inches in downtown San Jose. Figure 3.3 shows the variation in rainfall between the upper and lower parts of the watershed.

#### *HYDROLOGY – OVERVIEW*

The watershed’s Mediterranean-type climate produces different flow characteristics for the Guadalupe River in the dry and wet seasons. Wet season flows can be large and episodic, while dry season flows are lower but more uniform. This pattern is also observed in the urban creeks, and differs with the more managed and less variable outflows from the reservoirs.

Figure 3.4 shows the flow gages used in the loading analysis (Section 4) for this watershed, and flow data in cubic feet per second (cfs) for each gage from October 2003 through May 2004. The scale extends up to 1,000 cfs for the creeks and the river (the top hydrographs), and the episodic occurrence of high-flow events, even during this dry winter, are evident. The scale extends just to 100 cfs for the reservoir outlets (the bottom hydrographs), where the constant base flow and muted hydrograph are in contrast to the creeks and the river.

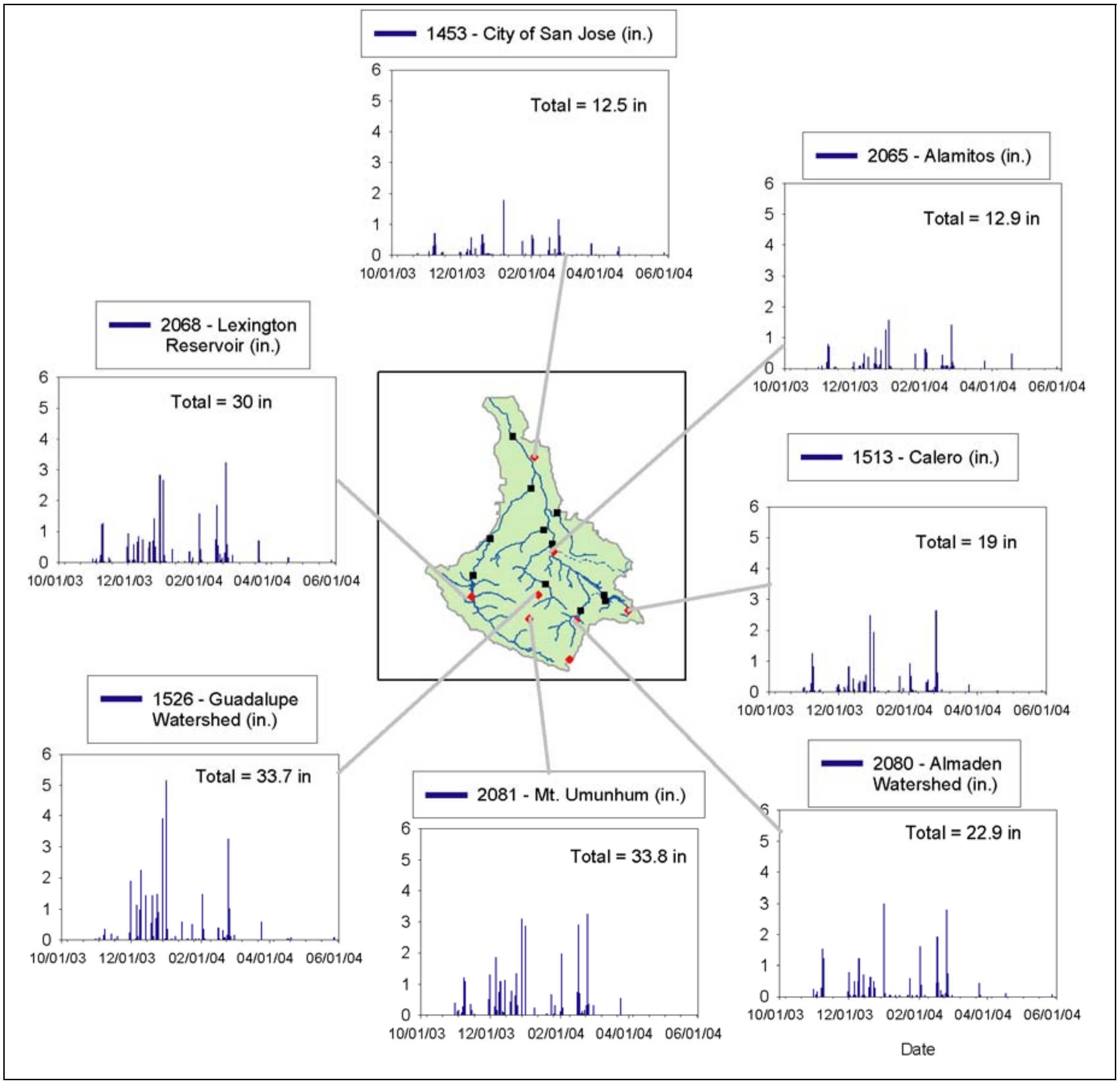



**Figure 3.3 Measured Rainfall (in. per day) at Selected Rain Gages within the Guadalupe River Watershed**

*Citation: Figure 2-3 in Final Conceptual Model Report (Tetra Tech 2005c)*

Mt. Umunhum, the highest peak in this watershed, receives the highest rainfall. Second highest rainfall occurs in the eastern upper watershed (Lexington). Rainfall drops substantially in the lower elevations to the north.

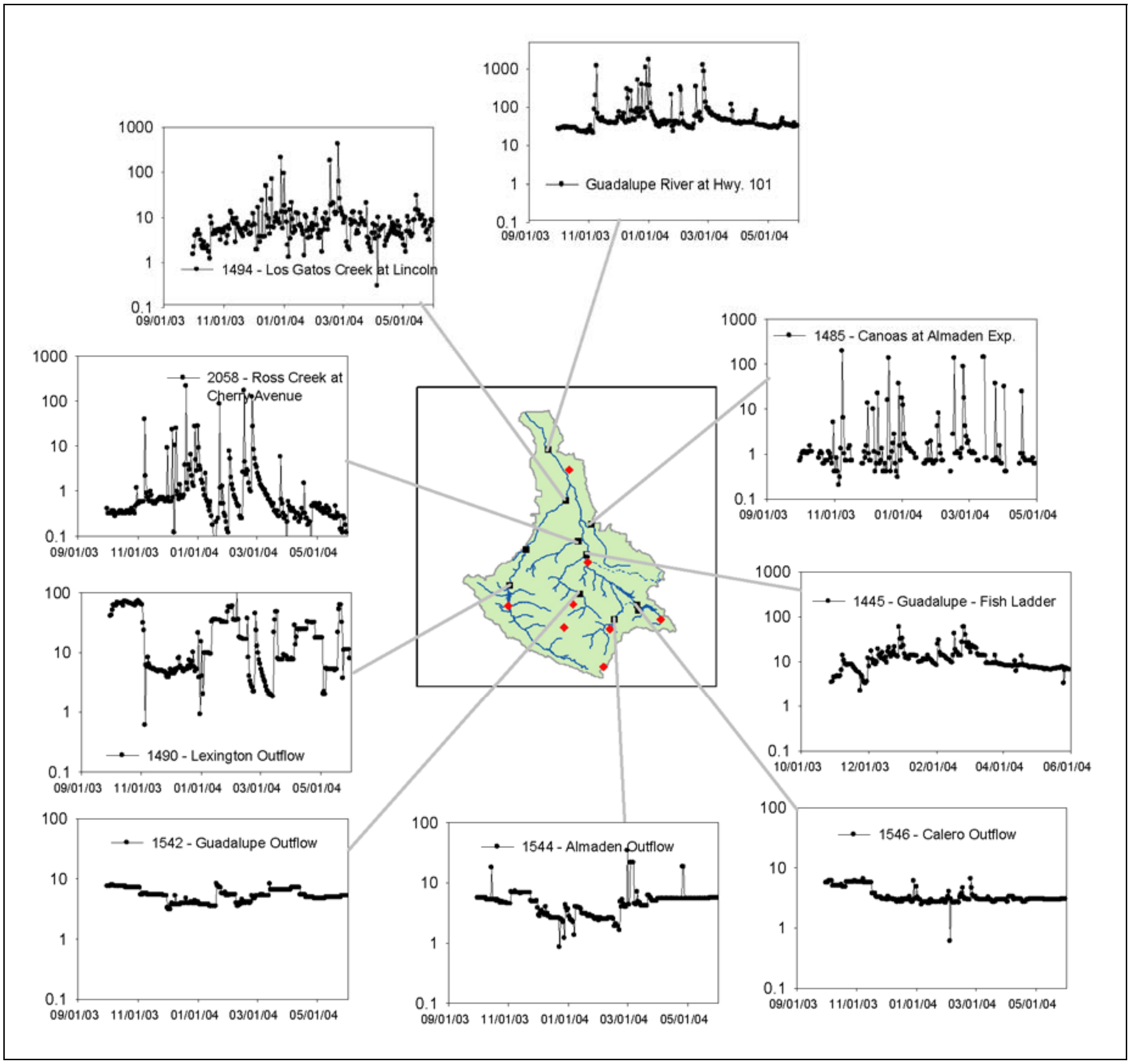



**Figure 3.4 Measured Stream Flow (cfs) at Selected Gages within the Guadalupe River Watershed**

*Citation: Figure 2-4 in Final Conceptual Model Report (Tetra Tech 2005c)*

The top hydrographs (creeks and the river) illustrate the episodic nature of high-flow events. The bottom hydrographs (note change in vertical scale from 1,000 to 100 cfs) illustrate constant base flow and a comparatively muted hydrograph.

Figure 3.5 shows the long-term flow record from 1930 to 2002 for the USGS gaging station at St. John's Street in San Jose, which was decommissioned due to channel modifications on April 30, 2003. USGS set up a replacement gaging station which began recording data on May 23, 2002 downstream near the San Jose Airport by Highway 101 (Figure 3.2).

According to data from the older gage, the median flow in the Guadalupe River at St. John's Street was 4.5 cfs between 1960 and 2002. The maximum daily flow was 7,870 cfs, while the average daily flow was 54 cfs over this same period of record. In the wet season, flows increase substantially during storm events. Between 1930 and 1998, peak flows at the old USGS gage varied from 125 cfs in 1960 to 10,500 cfs on March 10, 1995. The large flows, such as in 1995 and 1998, flooded downtown San Jose. In addition, flows in the lower river (just below the confluence with Los Gatos Creek, see Figure 3.2) increased between the 1950s and the 1990s, as seen in Figure 3.5, partly as a result of urbanization. Urbanization increases the impervious surface area, which changes the hydrograph (storm flows reach a higher peak, sooner). Consequently, extensive flood control projects have recently been undertaken, as we describe in the next section.

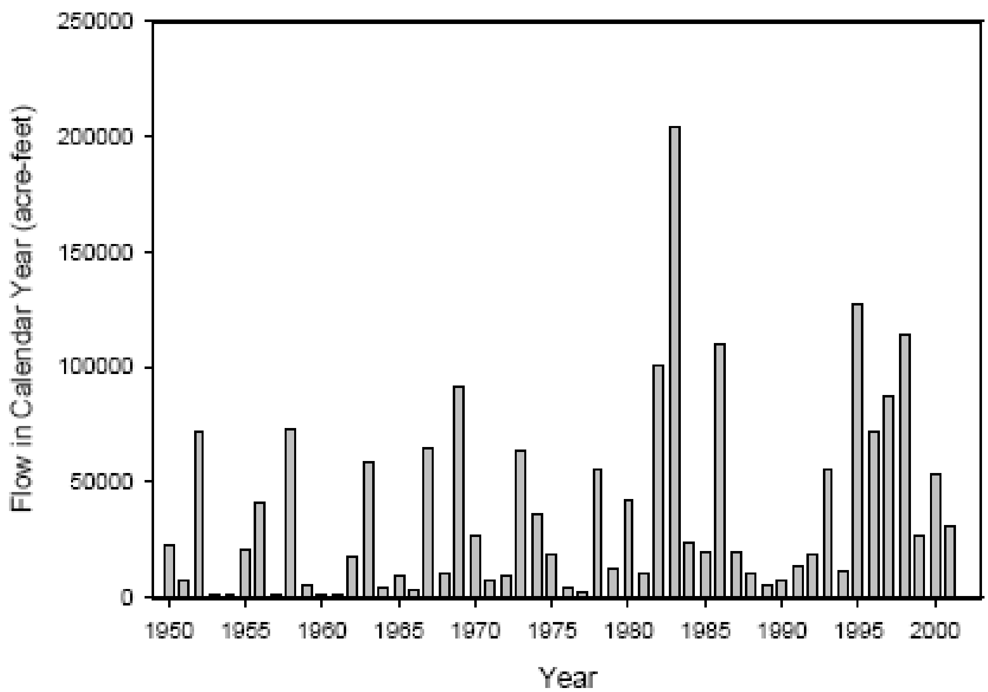



**Figure 3.5 Flows (acre-ft) in Guadalupe River at St. John's St.**

*Citation: Figure 2-5 in Final Conceptual Model Report (Tetra Tech 2005c)*

Year-to-year variability in total wet weather flows. Note that there is an increase in peak flows over time possibly as a result of greater urbanization.

***HYDROLOGY – MODIFICATIONS TO GUADALUPE RIVER***

The Guadalupe River is highly modified; importantly for this TMDL project, these modifications affect sediment transport and locations where mercury-laden sediment accumulates. Modifications to control flooding on the Guadalupe River have occurred since about1866, about the time the river was diverted from Guadalupe Slough to Alviso Slough (Figure 3.6). New Almaden Mining District was in operation prior to 1866, so mercury-laden sediment has likely accumulated in Guadalupe Slough and the adjacent salt ponds.

In 1963, local agencies channelized the lower Guadalupe River and added new levees along Alviso Slough out to South San Francisco Bay. In the early 1960s, they also rerouted Canoas and Ross creeks to flow into the Guadalupe River at different locations, and channelized the lower reaches of both creeks. More recently, highway engineers modified the river channel to facilitate construction of the 1975 Almaden Expressway (see Figure 3.2). These modifications involved widening and moving about 3,000 feet of channel to the east and filling the original channel.

In the late 1970s, flood control engineers modified channels in the lower reaches of Randol, Greystone, and Golf creeks and built levees along Alamitos Creek from the Harry Road bridge to the confluence with Almaden Lake. Some of these flood control projects may have decreased the extent of erosion along stream banks by installing bank protection and changing the energy gradient to reduce water velocity in fast-flowing segments. Others may have shifted erosion and associated sediments and mercury to elsewhere in stream corridors.

In 1999, in an effort to help fish migrate above the Alamitos Drop Structure, the Water District added a fish ladder below Almaden Lake (Figure 3.2). (A drop structure is one of many engineered structures designed to prevent channel incision or down-cutting by slowing down the water velocity; sediment accumulates behind structures that slow water).

Currently, three flood control projects are underway for the Guadalupe River, which will change sediment transport processes in the River. The Lower Guadalupe River Project is designed to increase the capacity of the river channel between Highway 101 and the Union Pacific Bridge in Alviso so that it can better handle a 100-year flood. The recently completed Downtown Project is designed to make channel improvements along a three-mile stretch from Interstate Highway 880 to Interstate Highway 280. It included a 3,000 cfs bypass channel to route flood flows underground, instead of through the natural river channel. The next project to be constructed is the Upper Guadalupe Project, which extends from I-280 to Blossom Hill Road along the Guadalupe River and from I-880 to U.S. Highway 101 along Ross and Canoas creeks.

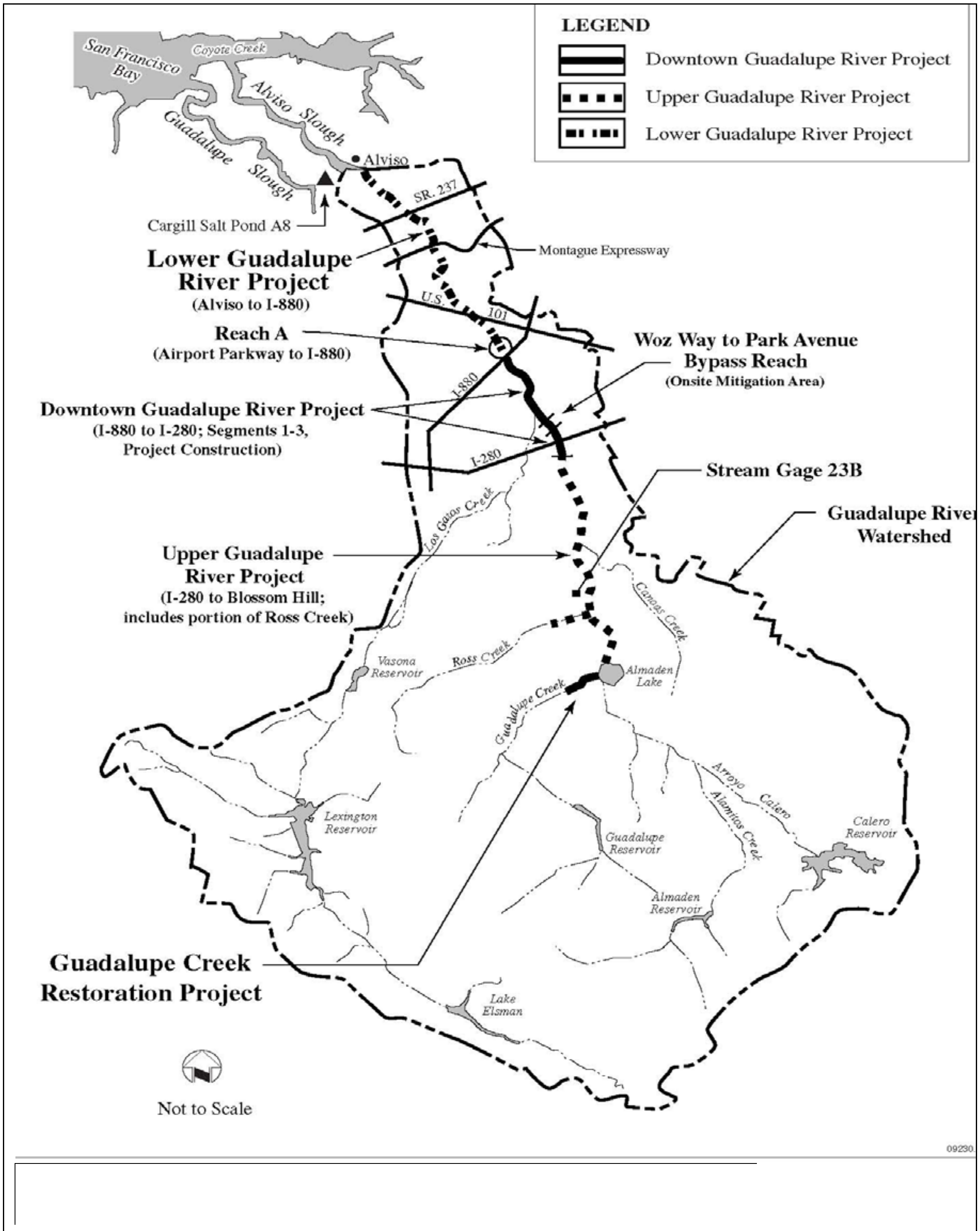



**Figure 3.6 Recent Guadalupe River Watershed Flood Protection Projects**

*Citation: Figure 2-1 (SCVWD 2002)*

As mitigation for the Downtown Project, in 2001 the flood control agencies modified channels to improve stream habitat along a portion of Guadalupe Creek above its confluence with Alamitos Creek and below Masson Dam. Sediment was also removed from the creek in conjunction with this project and an earlier 1999 project involving construction of a fish ladder to bypass Masson Dam.

#### *HYDROLOGY – MAINTENANCE*

Flood control measures have included the removal of sediment for routine maintenance from the various drop structures and flood control structures from various parts of the Guadalupe River watershed (see Table 2-1 in *Final Conceptual Model Report).* Sediment removal also removes mercury and prevents it from reaching San Francisco Bay. The Water District has also conducted stream bank protection projects to prevent erosion. For example, in the Guadalupe River watershed, engineers reworked about 13,000 linear feet of bank between 1986 to 1995. In the future, an additional 12,000 linear feet is slated for bank protection (see Upper Guadalupe River Project on Figure 3.6).

#### *HYDROLOGY – RESERVOIRS*

Prior to the mining era, there were no lakes or other large natural impoundments in the Guadalupe River watershed. All lakes and reservoirs were constructed behind dams or fill former quarry pits (see *Definitions* in Section 8.2). The watershed contains six water conservation and storage reservoirs (Figure 3.2). These reservoirs are Calero Reservoir on Calero Creek; Guadalupe Reservoir on Guadalupe Creek; Almaden Reservoir on Alamitos Creek; and Lake Elsman, Lexington Reservoir, and Vasona Lake on Los Gatos Creek. The three reservoirs in or near the former mining area, Almaden, Guadalupe, and Calero, were built in the creek canyons. Water is transferred to Calero Reservoir from Almaden Reservoir via the Almaden-Calero Canal and from the Central Valley Project (CVP). The volume of water retained in the reservoirs changes over the year, depending on precipitation, releases to the streams and evaporation. Vasona Lake is small, and spills when large storms occur, such as from February 25-27, 2004. The other reservoirs rarely spill. Hydraulic modeling for Almaden Reservoir estimated that it would spill 6 percent of the time in 100 years. The four other reservoirs (besides Vasona) may spill in a 100-year flood event, but did not spill in 2003 or 2004.

#### *GEOLOGY*

The Guadalupe River watershed can be divided into three regions: 1) an upland region with bedrock outcrops, 2) an alluvial plain, and 3) a baylands region. Sedimentary and metamorphic rocks underlie most of the upland region, chiefly belonging to the Franciscan Formation. The formation includes common sedimentary rock types laid down on ancient seafloors, such as sandstone, shale, graywacke, limestone, and conglomerates, and common metamorphic and volcanic rocks, such as chert, serpentinite, greenstone, basalt, and schist. The river's alluvial plain—the area where it has long flowed, flooded, and deposited sediments—overlies a deep structural basin filled with up to 1,500 feet of Plio-Pleistocene and Quaternary unconsolidated alluvial materials. The alluvial deposits consist of well-graded, interbedded fine sands and silts with some gravels. Coarse gravel deposits are present in some reaches of the Guadalupe River where it flows across the ancestral channel, rather than in relocated channels. The portion of the watershed south of California State Highway 237 is underlain by Bay muds and fine-grained silts and clays.

For the following description of the uplands mineralized geology from the *Final Conceptual Model Report*, Tetra Tech relied on the definitive tome: *Geology and Quicksilver Deposits of the New Almaden District, Santa Clara County, California, Geological Survey Professional Paper 360* (Bailey & Everhart 1964), and other sources such as new geologic maps (McLaughlin et al. 2001), and (per Summers 2007) several papers by James Rytuba of USGS (Rytuba & Enderlin 1999, Rytuba et al. 2000, Rytuba 2000, Rytuba 2005).

Mercury mineralization in the South San Francisco Bay region is chiefly associated with serpentine intrusions into the Franciscan Formation, where the serpentine has been hydrothermally altered to silica carbonate. The naturally occurring mercury is principally in the form of the mineral cinnabar (mercury sulfide) in the silica carbonate. Because the rock types in the Franciscan Formation contain limestone and carbonates, soils derived from these deposits are alkaline, as is the runoff and mine seeps. The alkaline seeps are in contrast to other mining areas with acid-mine drainage, where the ore was associated with pyrites and other sulfide minerals, such as the gold mines in the Sierra Nevada and the New Idria Mine, where the mercury ore was formed due to hot springs solution deposits.

The Franciscan Formation and its related serpentine beds underlie the New Almaden Mining District of the upper Guadalupe River watershed. Silica carbonate bedrock is found in scattered areas of the New Almaden Mining District. To extract the ore from these rocks, miners dug and blasted deep underground shafts and tunnels. New Almaden is the deepest mercury mine in the world—just over 2,000 feet deep. Over 99 percent of the ore was extracted from underground. A small percentage was extracted via open cuts and surface mines in Mine Hill and around the Enriquita fault zone, which cuts through the Guadalupe Reservoir. In addition, a placer deposit (surface mineral deposit formed by mechanical and weathering processes) of cinnabar gravels was found in the lower portion of Deep Gulch Creek. The average cinnabar content was an amazingly high 75 percent; this deposit was mined nearly to exhaustion.

Dispersed cinnabar may also be present in small, never-mined silica carbonate outcrops and in the remaining unexplored subsurface veins. Elevated total mercury levels have been found in soils overlying the silica carbonate deposits. Other rock types and locations containing some cinnabar include graywacke and shale in the Harry area and altered greenstone and tuff in the nearby upper Cora Blanca and Los Angeles areas of the New Almaden Mining District (all near Mine Hill).

Recently produced geologic maps for the Los Gatos area show isolated, small silica carbonate deposits in the Limekiln Canyon area of the Lexington watershed. There were no other potential mercury deposits identified in the Lexington Reservoir watershed. The Limekiln Canyon did not have elevated total or particulate mercury when sampled in the wet season of 2004 (Tetra Tech 2005a). Other silica carbonate deposits outside the New Almaden Mining District include small deposits along the route of the Almaden-Calero Canal near its discharge point to Calero Reservoir and in several places east of the reservoir, and in small areas near Cherry Creek on the west side of the reservoir. The

Santa Teresa Hills between Canoas and Calero creeks also have limited areas with silica carbonate formations; mining operations were limited in these hills.

### *3.4 Mining Operations*

Mining in the New Almaden Mining District began in 1846 and continued until 1975. American Indians and Mexicans discovered the mercury deposits sometime before 1845. Figure 3.7 (an oversized figure at the end of this section) shows the major mine-related features in the upper Guadalupe River watershed. For this description of mining operations from the *Final Conceptual Model Report*, Tetra Tech relied on the Bailey & Everhart 1964 book, new geologic maps (McLaughlin et al. 2001), and (per Summers 2007) several papers by James Rytuba of USGS (Rytuba & Enderlin 1999, Rytuba et al. 2000, Rytuba 2000, Rytuba 2005).

An excellent historical perspective of the New Almaden Mining District is presented in : *Geology and Quicksilver Deposits of the New Almaden District, Santa Clara County, California, Geological Survey Professional Paper 360* (Bailey & Everhart 1964). The introductory paragraph provides sufficient historical context with such great appeal to a wide range of interests that we repeat it here:

> *"The recorded history of the great quicksilver mines on the New Almaden property extends through a period of more than 100 years and encompasses the transition of California from a sparsely populated Mexican territory to a rich and populous State—a transition that profoundly affected the mines, the miners, and the methods of mining and reducing ores. Many of the resultant changes that influenced the development of quicksilver mining in the United States are emphasized, whereas others only mentioned briefly will be of interest to persons specializing in different fields of historical research. The geologists, for example, will perhaps be most interested in the changing concept of the ore gangue, from an early belief that it was an extremely wide fissure filling to the present realization that it is the silicified and carbonatized border of intrusive serpentine. The mining engineer will be more interested in the development of methods of mining. In the early days of the district, ore was carried in leather bags by Mexicans who climbed up notched poles from stopes hundreds of feet underground, whereas in later times the mines had powerful hoists and pumps; and such new techniques as the methods of timbering large horizontal stopes were first developed at the New Almaden mine. The metallurgist's interest will center around the development of quicksilver-reduction equipment from crude retorts made of gun barrels to modern Herreshoff and rotary furnaces. A lawyer will find much of interest in the fact that many laws concerning ownership of land formerly held under grant from a foreign country were first tested in the legal battles over the New Almaden property, and he might diligently follow the cases through State and district courts to the U.S. Supreme Court, and to a final settlement by international arbitration. A sociologist will perhaps be surprised to learn of a mining community, half Mexican and half American, wherein as early as 1870 medicine, dentistry, entertainment, and educational lectures were provided for all through compulsory monthly payroll deductions. The history of the mine contains*

> *much of interest to a historian, especially the part relating to the critical Civil War period, when the quicksilver so necessary for the operation of the precious-metal mines of the Mother Lode and the Comstock Lode was nearly lost to the Northern States, through statewide feeling against the governmental seizure of the New Almaden mine ordered by President Lincoln."*

The appeal of New Almaden extends beyond the professions mentioned above (geologists, engineers, metallurgists, lawyers, sociologists, and historians) to fiction writers—notably novelist Wallace Stegner, in his epic novel *Angle of Repose,* winner of the 1972 Pulitzer Prize. Stegner included a character based on "a rewriting of the personal memoirs of Mary Hallock Foote, a famous illustrator and writer in the Victorian west. Her husband was Arthur DeWint Foote, a famous mining engineer who served a brief year as chief engineer at New Almaden in 1876. Much of the content of Stegner's work is drawn from Mary's writing, including the title, having stated in her memoirs that she and Arthur reached their "angle of repose" when they settled at the North Star mine in Grass Valley and ceased their all too frequent moves about the American west in Arthur's capacity as an engineer" (Cox 2006).

#### *PRINCIPAL NEW ALMADEN MINES*

The principal New Almaden mines (New Almaden/Mine Hill, America, Providencia, Enriquita, San Antonio, San Mateo and Senador) produced a total of about 38.4 million kilograms of mercury; about 70 percent of this was mined before 1875, and about 80 percent before 1935. About 75% of all ore from the principal mines was processed at the Hacienda Furnace Yard (Cox 2000). The Guadalupe mine produced nearly 4 million kilograms of mercury (Bailey & Everhart). The early mined veins contained rich ore of up to 20 percent mercury, which was hand-sorted prior to processing in furnaces and retorts. In later years, the amount of mercury in the ore declined to 0.5 percent.

The average grade of the ore processed over the 130-year life of the mines was nearly 4 percent, about a flask (76 pounds) of mercury per ton of rock. Most of the ore came from Mine Hill. Miners roasted the ore in retorts or furnaces at a temperature of 700°F–1,200°F; the efficiency of the equipment varied, resulting in varying mercury content in the waste calcines. Large furnaces and retorts were present in Hacienda Yard and on Mine Hill, which generated significant waste deposits. On the banks opposite the Hacienda Yard, stood an additional group of 14 small furnaces. Mining wastes from these retorts are still present on the slopes above Alamitos Creek. Retorts, used for shorter periods of time, were present at the Guadalupe, Senador, Enriquita, and San Mateo mines, resulting in smaller waste dumps at these sites. Small retorts, often portable units, were used at the Day Tunnel, upper Deep Gulch Creek, and San Cristobal Tunnel.

In accordance with common mining practices at the time, workers disposed of roasted mining wastes, called calcines, and other waste in or near the creeks so the materials would be transported downstream by winter flows. Guadalupe and Almaden reservoirs were constructed in 1935 in creek canyons containing calcines, and Guadalupe Reservoir reportedly covers a former processing area. Calcines and other mining wastes are still present along the banks of Alamitos Creek, and along Deep Gulch, Jacques Gulch, and Guadalupe Creek above Camden Avenue. Owing to the chemical properties of the roasted carbonates, once wetted, the calcines form a weak cement. Mining wastes are thus sometimes found as cemented deposits along the creek banks, particularly in long stretches of Alamitos Creek.

Field surveys conducted in the summer of 2003 as part of TMDL development identified the locations of reaches of the creeks—on readily accessible lands—where calcines were observed. Survey results appear in Figure 3.8 (a second oversized figure at the end of this section). Photographs of creek reaches with cemented and loose calcines, and other mining waste deposits, are shown in Figure 3.9 (the third oversized figure at the end of this section). For example, above the Hacienda Furnace Yard along Alamitos Creek, there are large non-cemented deposits of calcines on the slopes above the creek. Present on the banks are both early calcines composed of cobble-sized material and later calcines from the Scott furnaces composed of smaller material. Below the Hacienda Furnace Yard, in the reach of Alamitos Creek between Bertram Road and Harry Road, there are small calcine deposits along the banks, some of which are cemented and some loose. Many of these deposits are above the low flow channel. A small area of furnace dust is present under the Almaden Road Bridge. The survey also pinpointed numerous other waste sites: On Alamitos Creek downstream of Harry Road, there are areas with calcines, which are often cemented and limited in extent, such as six sites between Harry Road and Greystone Lane. Survey workers also observed calcines in the gravel bars along the entire reach of Alamitos Creek, and along the banks of upper Guadalupe Creek near the former Guadalupe Mine outside of the Almaden Quicksilver County Park. A partly vegetated mining waste pile is present at Hicks Flat on the opposite side of Guadalupe Creek from the main mine.

#### *Smaller, Less Productive Mercury Mines*

Mercury extraction operations in the area also extended to three much smaller mercury mines, the Santa Teresa and Bernal mercury mines on the eastern side of the Santa Teresa Hills, and the Hillsdale Mine on a hill now commonly referred to as the county communications center (see Figure 3.2). Santa Teresa and Bernal mercury mines drain to Canoas Creek. Hillsdale Mine drains to Coyote Creek, and therefore is located outside the Guadalupe River watershed.

Mining companies operated the Santa Teresa Mine as an underground mine from three main adits (horizontal passages from surface to mine). In 1903, they installed a 40-ton Scott furnace, which produced nine flasks of mercury.

The Bernal Mine, located in Santa Teresa County Park, appears to now drain to Coyote Alamitos Canal, and Canoas Creek. The Bernal Mine was an underground mine with two shafts and an adit by 1902. In 1942, miners excavated two new mine openings, and in 1946, extended the adit and installed a retort. The mine was idle by 1947, and no evidence of mercury production was found in the abandoned retort.

#### *Definition of New Almaden Mining District for TMDL*

For the purposes of the Guadalupe River watershed mercury TMDL, the New Almaden Mining District is defined as the Los Capitancillos ridge and its extensions, and the processing areas on adjacent hillsides (Figure 4.1). Such processing areas, for example, include both sides of Alamitos Creek next to the Hacienda Furnace Yard, and mining waste piles at Hicks Flat. Guadalupe mine is located on Los Capitancillos ridge contiguous with the New Almaden Mining District, but because of separate ownership, it has retained a distinct name.

#### *NEW ALMADEN COMPARED TO CALIFORNIA'S OTHER MINES*

In preparing the conceptual model and surveying the watershed, it was useful to compare the geology and landscape conditions of New Almaden with other California mercury and gold mines, and to examine data collected on their mercury output and pollution problems. One thing that California mercury and gold mines have in common is nearly all drain to San Francisco Bay. Three basic factors, aside from the historic management of mine waste materials, which is problematic at all mine sites, influence the extent of mine-related mercury pollution: 1) amount of production, 2) presence of alkaline or acid conditions associated with the mineral deposits, and 3) methylmercury production.

##### Amount of Mercury Production

The amount of mercury produced has not yet been reliably correlated to downstream concentrations of total mercury. In the Final Conceptual Model Report, Tetra Tech compared the mercury concentrations in runoff and creeks below various California gold and mercury mines. The highest total mercury concentrations in nanograms of mercury per liter of water (ng/l, parts per trillion) were (Tables 2-6 and 2-9, Tetra Tech 2005c):

| | |
|---|---|
| 1,040,000 | Gambonini Mercury Mine, Walker Creek (tributary to Tomales Bay in western Marin County), collected by Water Board staff in a large storm event |
| 110,000 | New Almaden Mining District sample from Alamitos Creek collected by county parks staff in a storm event that occurred when the soil was already saturated |
| 38,304 | Downstream of (unspecified) gold mine |
| 464 | Guadalupe River sample collected by Tetra Tech during a storm in wet season 2004 |
| 191 | New Almaden Mining District creek sample collected by Tetra Tech in a very small storm event in wet season 2004 |

The Gambonini Mercury Mine data were collected in a two-month period in 1998 with great precision during a large winter storm and resulted in an accurate load estimate of an alarming 82 kilograms of mercury discharged in these two months (Whyte & Kirchner 2000). None of the data from the other gold and mercury mines discussed above or in Section 2.2 of the *Final Conceptual Model Report* even approach the level of accuracy of the Gambonini Mercury Mine load study. Therefore, the available data are insufficient to support any conclusions based on the range of known mercury concentrations downstream of mines. Conclusions can be drawn, however, based on the relative size of the mines, their acid or alkaline conditions, and methylmercury production.

Between 1940 and 1970, there were seven active mercury mines operating in western Marin County, of which Gambonini was the largest and produced about 5,000 flasks (New Almaden produced 200 times more mercury than Gambonini—about 1.1 million flasks). All ore from West Marin was processed at Gambonini (most of the ore from New Almaden was processed at Hacienda Furnace Yard). Following major storms in 1982, the sediment dam that had contained the Gambonini mining wastes failed. USEPA reacted quickly to the 1998 load estimate by undertaking a Superfund cleanup action, completed within nine months. From 1999 to 2000, USEPA and the Water Board remediated a large part of the Gambonini Mine site. Remediation actions included the use of geotechnical engineering techniques and biostabilization practices to stabilize the waste piles. These are virtually the same measures the Santa Clara County Parks Department used in the Almaden Quicksilver County Park cleanup effort discussed below.

#### Presence of Alkaline or Acid Conditions

Acid mine drainage—which compounds mercury pollution problems with other pollutant issues—differs greatly among California mines as a result of local geology. Not only are highly acidic waters toxic to most living creatures, but acid dissolves much more mercury and other toxic metals out of the mining wastes than alkaline conditions. This results in higher concentrations of dissolved mercury which, under the right conditions, is readily methylated and bioaccumulated. In terms of mercury mines, the two major types of mercury deposits are silica-carbonate deposits and thermal springs. Thermal springs vary greatly in mineral content. Cinnabar is the dominant mercury form in both types, but secondary mercury compounds are more prevalent in thermal spring areas. Acid mine drainage is not as prevalent at mercury mines as at gold mines, since gold deposits are typically associated with larger quantities of iron sulfide minerals that generate sulfuric acid.

#### Methylmercury Production

Methylmercury production and bioaccumulation are also important factors in this comparison of different California mines. Median annual methylmercury downstream of mercury mines and mineral springs in the Cache Creek watershed (in the Central Coast Range mineral belt) are commonly about 0.5 ng/l (Table B.1, *Cache Creek, Bear Creek, and Harley Gulch TMDL for Mercury*, November 2004), but much higher in some locations. For example, in summer most of the water in Sulphur Creek comes from mineral springs high in dissolved total mercury and reaches an astoundingly high 20 ng/l methylmercury. Mercury sources in Bear Creek are mining waste and natural springs, which produce high fish concentrations of up to 6 milligrams mercury per kilogram fish tissue (mg/kg, parts per million) in Sacramento pikeminnow. Mercury in 40 cm largemouth bass in Clear Lake is 0.6 mg/kg on average, where the highest open water methylmercury concentrations are 1.4 ng/l.

In contrast, methylmercury in creeks downstream of New Almaden ranged up to 0.2 ng/l in a reservoir tributary in the wet season, but methylmercury in the hypolimnion of Guadalupe Reservoir reached a stunning concentration of nearly 13 ng/l in the 2004 dry season. Not surprisingly, fish in Guadalupe Reservoir have the highest mercury concentrations in the watershed, up to 13 mg/kg, with an exceptionally high average concentration of 6.1 mg/kg in 40 cm largemouth bass.

In conclusion, New Almaden is of significant concern relative to California's other mercury and gold mines due to its much larger mining and methylmercury production and bioaccumulation. On the other hand, conditions at New Almaden are alkaline, hence the acid mine drainage problems associated with other mercury mines in the Coast Range do not occur at New Almaden.

### *3.5 Cleanup In and Downstream of New Almaden Mining District*

#### *CLEANUP OF ALMADEN QUICKSILVER COUNTY PARK*

Santa Clara County purchased most of the New Almaden mines property in 1975. Pursuant to California Superfund authority, the Department of Toxic Substances Control (DTSC) issued a Remedial Action Order to the County in October 1987. The County undertook an extensive response, including site assessment, risk assessment, remedial design, and construction. The scope of this effort was at least equal to this TMDL's data collection and conceptual model effort. The five sites that presented the greatest threat to human health from direct exposure were identified and cleaned up: Mine Hill, the Hacienda Furnace Yard, and the Senador, Enriquita, and San Mateo mines. While this effort went a long way toward addressing the most significant hazards to human health within the park, the issues of soil erosion and transport of mercury to water bodies and bioaccumulation were not addressed.

The County's major cleanup effort began in 1990. The County removed mercury-laden calcines and furnace dust piles around the main retort sites at Hacienda Yard, on top of Mine Hill, and near the Senador, Enriquita, and San Mateo mines, and then covered, re-graded, and re-vegetated the removal sites. The County placed most of the calcines in the San Francisco Open Cut on Mine Hill, where they too were covered with soil and revegetated. A two-foot soil cap was added over the remaining calcines at the Hacienda Furnace Yard. Calcines present on the opposite bank of Alamitos Creek from the Furnace Yard were not within the park and therefore were not addressed. The County buried those calcines removed from the Enriquita and San Mateo mines near the former retort sites.

The County also undertook erosion control measures on the steep slopes around the former furnaces and retorts. On the Hacienda Yard next to Alamitos Creek, workers installed a concrete cutoff wall and gabion and rock slope protection on the western bank. Cleanup proceeded to design specifications and visual confirmation of removal of mining wastes, but unlike most hazardous waste cleanup actions, no post-excavation samples were collected to confirm mercury concentrations.

More recently, observations from site visits to the former mines suggest that the calcine disposal areas within Almaden Quicksilver County Park are largely being protected from erosion by the vegetation and runoff control measures. Maintaining vegetation in this dry climate remains a challenge. Mining waste piles at former mines, such as near the Senador Mine, were seeded with grass, but the vegetative cover is thin, and active erosion is occurring in places. Gabions statewide have turned out not to be a long-term slope stabilization measure, and the upstream gabion at the Hacienda Furnace Yard is no exception to the rule—it is failing. These small maintenance problems will likely need to be addressed in future remedial actions under the TMDL.

#### *REMAINING CLEANUP CHALLENGES IN NEW ALMADEN QUICKSILVER COUNTY PARK*

Several contaminated locations within the Almaden Quicksilver County Park did not make it into the first substantial cleanup endeavor described above. The locations of known mine seeps and many remaining mining wastes are shown in Figure 3.8. Because the previous cleanup efforts were confined to the then-current park boundary, adjacent contaminated mining sites in the New Almaden Mining District were not sampled or remediated.

As previously discussed, calcines on the opposite bank of Alamitos Creek from the Hacienda Furnace Yard lie outside the park boundary, and thus remain to be addressed (two downstream sections are proposed to be addressed under the Natural Resources Damages Assessment cleanup action described below). Within the park, overburden piles remain near some of the mines, including the Providencia and Senador mines. Calcines and other mining wastes are present in Jacques Gulch, which discharges into Almaden Reservoir. They are also present in Deep Gulch, which discharges into Alamitos Creek. Both Jacques and Deep gulches are proposed to be addressed under the Natural Resources Damages Assessment cleanup action described below.

Other potential problem areas include the many miles of former mine roads in the park where mining wastes are evident in the larger cobble- and gravel-sized materials, which are actively eroding. Runoff in some of these areas could reach Jacques Gulch. Other old mine roads drain areas into both North Los Capitancillos Creek, which discharges into Guadalupe Reservoir, and directly into this reservoir. Mine seeps are present from former tunnels and adits, such as at the Day Tunnel and above Randol Creek, which both ultimately could reach Randol Creek, and then Alamitos Creek (also shown in Figure 3.8).

Figure 3.10 (an oversized figure at the end of this section) provides a summary, based on pre-remediation site assessments, of the total mercury concentrations in the Almaden Quicksilver County Park that were not removed or buried. If these areas erode into waters, they cause unacceptably high mercury loads.

#### *Pre-cleanup Soil Mercury Concentrations*

Prior to remediation, mercury concentrations in the mining wastes within the boundaries of Almaden Quicksilver County Park ranged from 10 – 1,000 milligrams of mercury per kilogram of soil (mg/kg, parts per million); the median of 37 sites was 84 mg/kg. Sediment samples from Deep Gulch Creek had total mercury ranging from 2 – 590 mg/kg on a wet weight basis. Sediment samples from Alamitos Creek collected below the reservoir had total mercury ranging from 1.5 – 95 mg/kg on a dry basis. A tributary of Randol Creek had total mercury of 5.1 – 230 mg/kg on a wet weight basis. Guadalupe Creek above Camden Avenue was sampled from 1980 to 1989; here total mercury ranged from 0.04 – 70 mg/kg on a dry basis. These data illustrate the high mercury concentrations present in soils and sediment in the mining district prior to the remediation efforts.

#### *POST-CLEANUP WATER MERCURY CONCENTRATIONS*

Though the County did not collect any post-remediation soil mercury samples, some water data are available from the two sets of stormwater samples collected each year as required by the Industrial Stormwater National Pollutant Discharge Elimination System General Permit required for industrial activities, including active and inactive mines and mineral processing. The Santa Clara Parks and Recreation Department (SCPRD) stormwater data from 1994 to 2003 (presented in the *Final Conceptual Model Report*) are samples from creeks that drain the park. These data illustrate the high mercury concentrations remaining in stormwater post-cleanup.

Tetra Tech evaluated a subset of SCPRD's data, the more recent data from 2000 – 2003. The highest mercury concentrations (up to 4,000 ng/l) occurred in January 2000 at most sites when the suspended solids were relatively high (several hundred milligrams of sediment per liter of water [mg/L]) during a large storm event (total rainfall was 2.52 inches the day before sampling and 3.11 inches the day of sampling). The single highest total mercury concentration (110,000 ng/l) was detected in a sample from Alamitos Creek just below the Hacienda Furnace Yard (Site D) on February 25, 2004, when rainfall was 0.12 inches the day before sampling and 2.6 inches the day of sampling, which had especially high suspended solids (2,000 mg/L).

#### *NATURAL RESOURCES DAMAGE(S) ASSESSMENT*

Federal statutes establish liability for natural resources damages to compensate the public for injury, destruction, and loss of federal, state, and tribal resources and their services resulting from hazardous substance releases. Natural resource trustees are authorized to act under those statutes, on behalf of the public, to assess and recover natural resource damages and to plan and implement actions to restore natural resources and resource services injured or lost as a result of the releases. USFWS was the lead trustee for a recently settled Natural Resources Damage(s) Assessment (NRDA). The planned restoration projects, which will reduce mercury discharges, include: two 150-foot sections of Alamitos Creek on the bank opposite Hacienda Furnace Yard, a 300-foot section of Deep Gulch Creek, and two areas in Jacques Gulch (which drains Mine Hill to Almaden Reservoir). More information on the NRDA is available at:
http://www.fws.gov/pacific and
http://www.dfg.ca.gov/ospr/organizational/scientific/nrda/NRDA.htm

#### *WATER DISTRICT MITIGATION, MAINTENANCE, AND RESTORATION PROJECTS*

A half-mile stretch of Guadalupe Creek was restored as mitigation for the downtown San Jose flood control project (see "Hydrology – Modifications to Guadalupe River"). Restoration included removal of mercury-contaminated sediments and recreation of a meandering stream course with native vegetation. Sediment-removal maintenance activities undertaken by the Water District for flood control purposes also remove mercury-contaminated sediment (see "Hydrology – Maintenance" above). Some of the restoration projects undertaken by the Water District include fish passage improvements (see "Hydrology – Modifications to Guadalupe River") and have included removal of mercury-contaminated sediments.

The Water District was awarded a USEPA 319(h) nonpoint source pollution reduction grant for mercury load reductions. The Water District removed mercury-contaminated mining wastes at four sites on Alamitos Creek. They removed a total of 3,725 cubic yards of contaminated soil—permanently removing 165 kg of mercury from the watershed, and restored 2,570 square feet of riparian habitat by replanting the creek banks with native vegetation. Based on these projects, they produced a "*Stream-bank Repair Guidance Manual for the Private Landowner: Guadalupe and Alamitos Creeks,*" which will useful for local residents needing to stabilize their creek banks.

***Key Points***

- California's New Almaden Mining District was the fifth-largest mercury mine in the world. Typical of its time (1845–1975), waste disposal practices largely consisted of piling the roasted ore (calcines) into creeks for winter rains to wash downstream. Consequently, downstream mercury methylation and bioaccumulation into fish is a significant problem relative to other mercury and gold mines in California.
- A strong scientific basis for this TMDL is provided by the many technical studies.
- The New Almaden Mining District is defined, for the purposes of this watershed-wide TMDL, as the Los Capitancillos ridge and its extensions and the processing areas on adjacent hillsides.
- Although progress has been made to cleanup mercury from New Almaden, vastly more remains to be cleaned up in and downstream of the New Almaden Mining District. No efforts have yet been undertaken to cleanup mercury from Santa Teresa, Bernal, nor Hillsdale mercury mines.

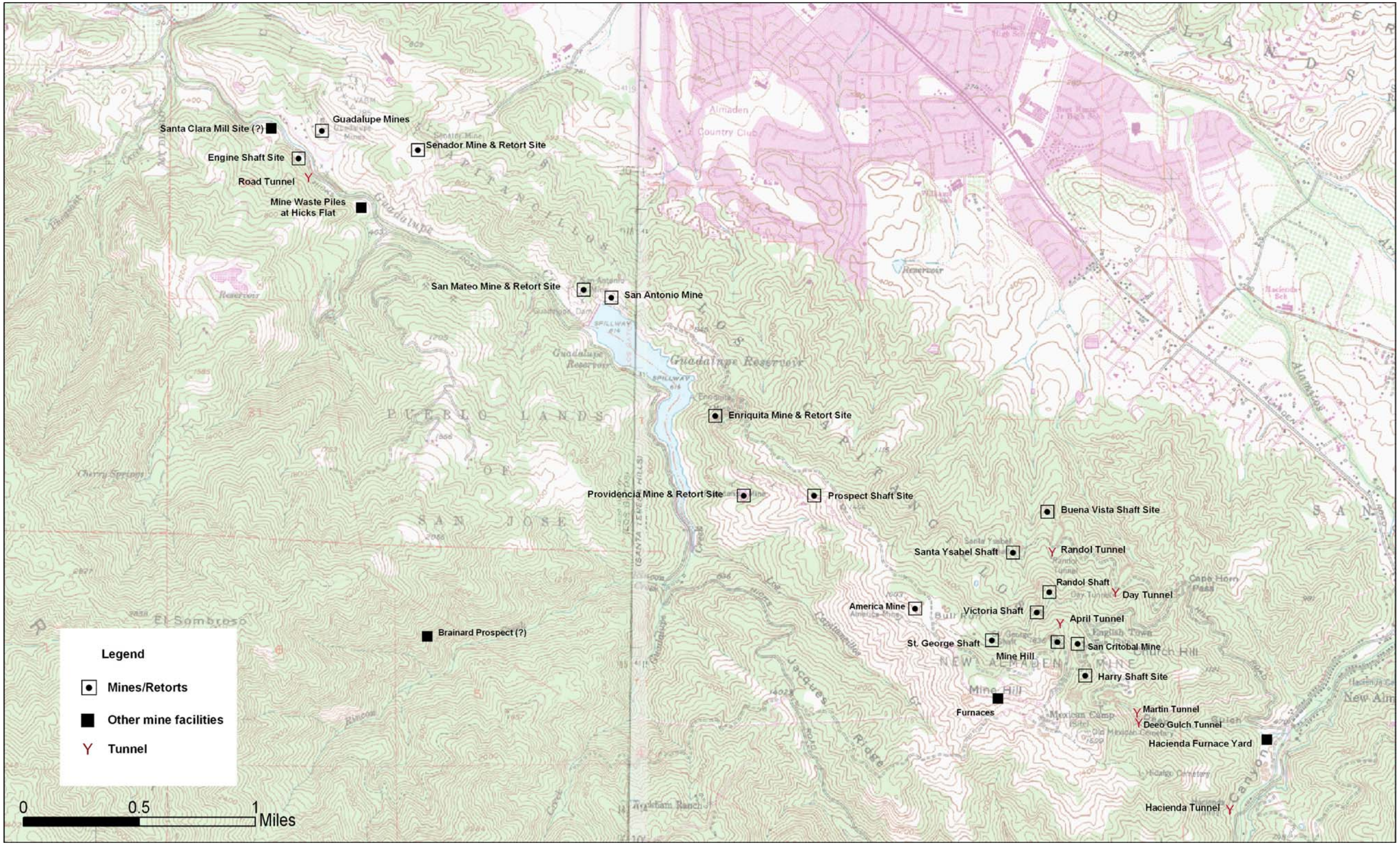



**Figure 3.7 Map of Major Mine-Related Features**

*Citation: Figure 2-6 in Final Conceptual Model Report (Tetra Tech 2005c)*

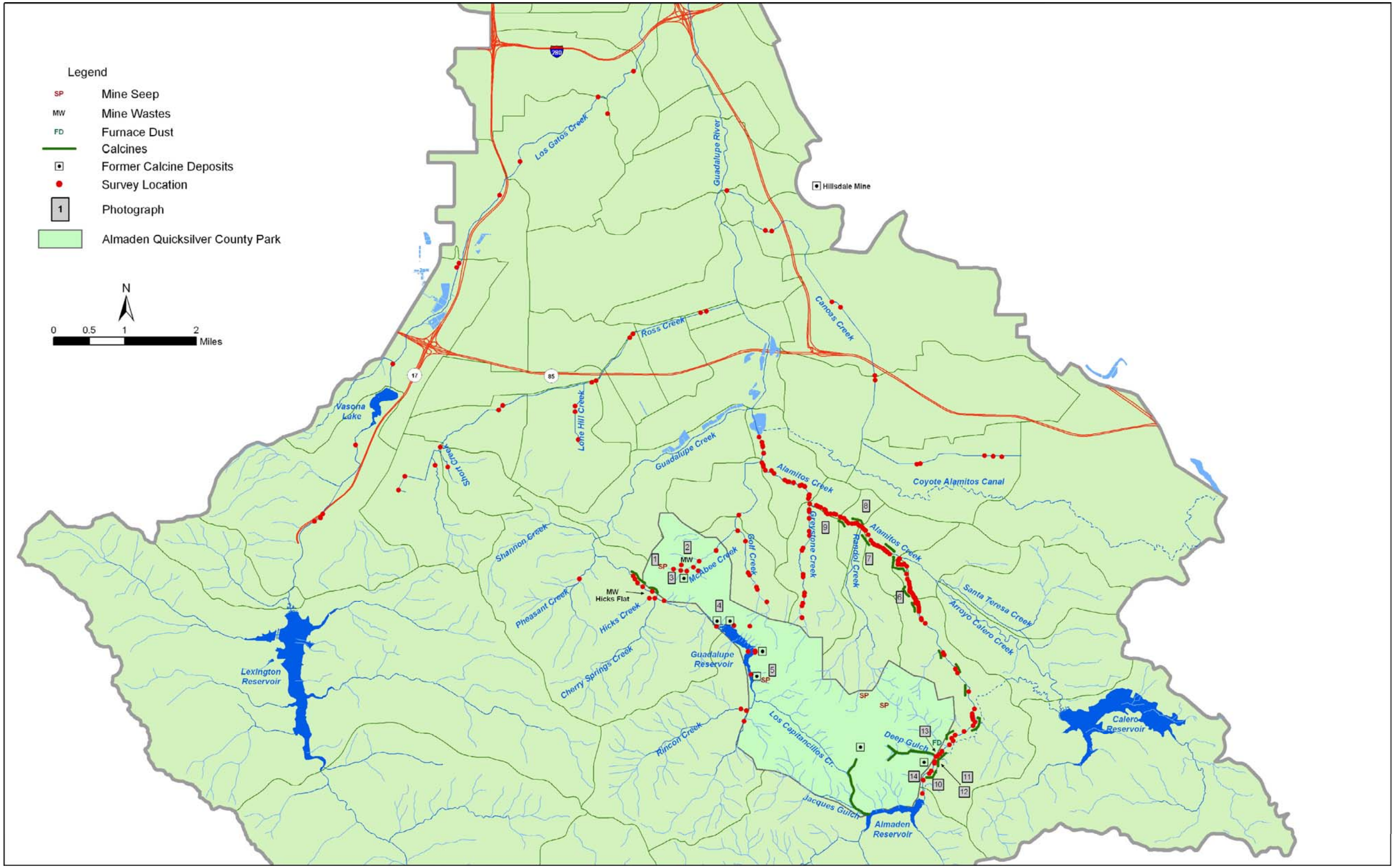



**Figure 3.8 Location of Exposed Mining Wastes and Seeps**

*Citation: Figure 2-8 in Final Conceptual Model Report (Tetra Tech 2005c)*

**Photographs of Exposed Mine Wastes, Seeps, etc.**

Photo 1 **Mine Seep at Senador mine**

Photo 2 **Mine Waste Piles at Senador Mine**

Photo 3 **Senador Mine Reduction Works**

Photo 4 **Silica carbonate outcrop at San Mateo Mine**

Photo 5 **Mine wastes and seeps near Enriquita Mine and seeps**

Photo 6 **Cemented calcine on Alamitos Creek**

Photo 7 **Cemented layers on Alamitos Creek**

Photo 8 **Undercut calcines on Alamitos Creek**

Photo 9 **Cemented calcines on Alamitos Creek**

Photo 10 **Calcines along the edge of Alamitos Creek**

Photo 11 **Calcines on the upper flood plain above Alamitos Creek**

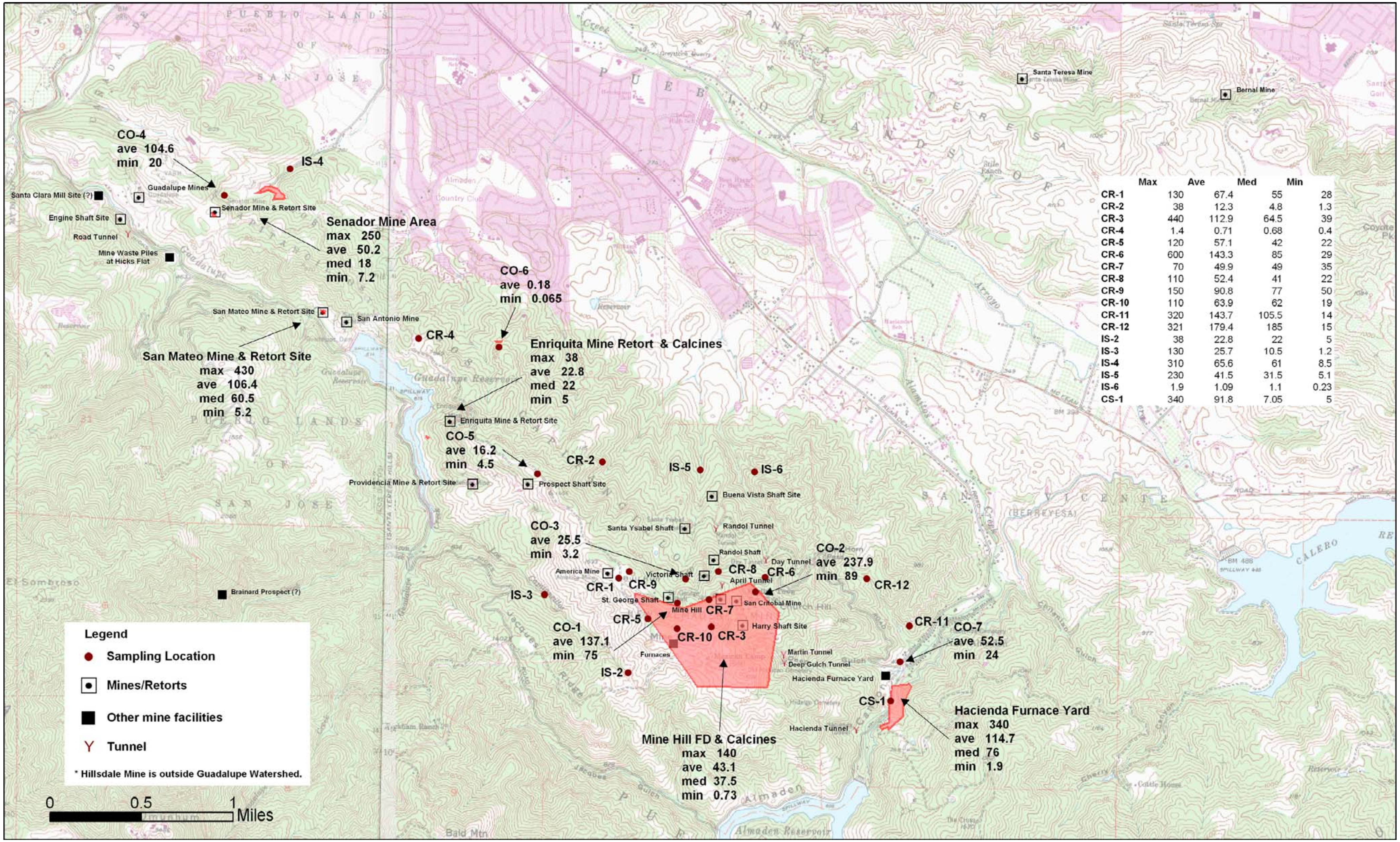
Photo 12 **Close-up of calcines above Alamitos Creek**

Photo 13 **Furnace dust beneath an Alamitos Creek bridge on New Almaden Road below Hacienda Furnace Yard**

Photo 14 **Calcine deposits on hill below road slip above Alamitos Creek**

**Figure 3.9 Photographs of Mining Wastes in Creeks**

*Citation: Figure 2-9 in Final Conceptual Model Report (Tetra Tech 2005c)*




| | Max | Ave | Med | Min |
|---|---|---|---|---|
| CR-1 | 130 | 67.4 | 55 | 28 |
| CR-2 | 38 | 12.3 | 4.8 | 1.3 |
| CR-3 | 440 | 112.9 | 64.5 | 39 |
| CR-4 | 1.4 | 0.71 | 0.68 | 0.4 |
| CR-5 | 120 | 57.1 | 42 | 22 |
| CR-6 | 600 | 143.3 | 85 | 29 |
| CR-7 | 70 | 49.9 | 49 | 35 |
| CR-8 | 110 | 52.4 | 41 | 22 |
| CR-9 | 150 | 90.8 | 77 | 50 |
| CR-10 | 110 | 63.9 | 62 | 19 |
| CR-11 | 320 | 143.7 | 105.5 | 14 |
| CR-12 | 321 | 179.4 | 185 | 15 |
| IS-2 | 38 | 22.8 | 22 | 5 |
| IS-3 | 130 | 25.7 | 10.5 | 1.2 |
| IS-4 | 310 | 65.6 | 61 | 8.5 |
| IS-5 | 230 | 41.5 | 31.5 | 5.1 |
| IS-6 | 1.9 | 1.09 | 1.1 | 0.23 |
| CS-1 | 340 | 91.8 | 7.05 | 5 |

**Figure 3.10 Map of Mercury Concentrations Remaining After Park Cleanup (mg/kg, parts per million)**

*Citation: Figure 2-7 in Final Conceptual Model Report (Tetra Tech 2005c)*

# 4. Source Analysis

Mercury in the Guadalupe River watershed comes from mercury mining waste, urban stormwater runoff, naturally occurring mercury in the soil, atmospheric deposition, and some other potential sources. Not every source contributes to every water body. Only water bodies receiving mining waste are included on the 303(d) list of impaired water bodies (SWRCB 2003). Table 4.1 (below) describes mercury sources to both impaired and non-impaired water bodies.

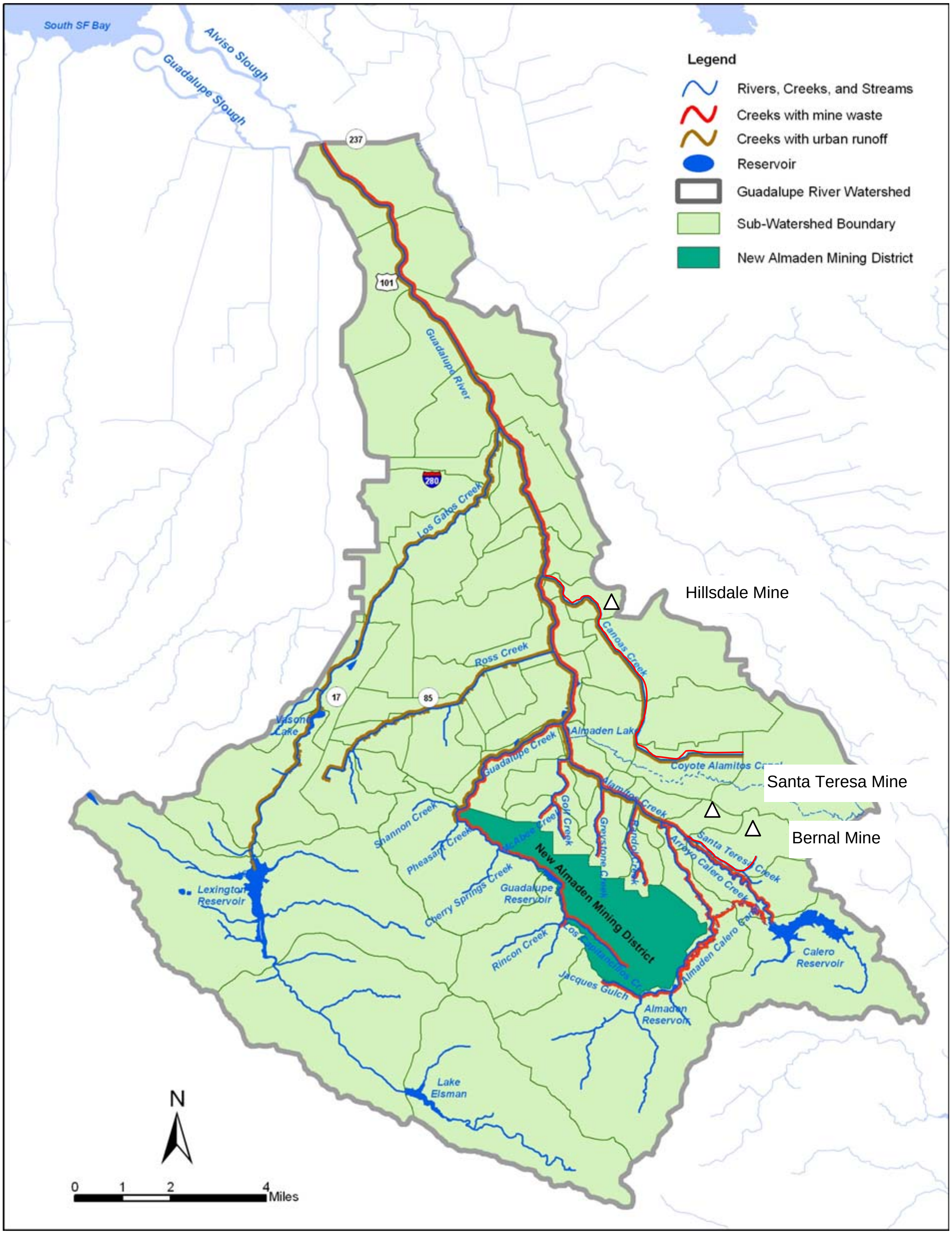
**Table 4.1 Sources and Water Bodies**

| Waters Downstream of New Almaden Mining District and Other Mercury Mines | | | |
|---|---|---|---|
| **Impaired Water Body[1]** | **Drains to** | **Source of Mining Waste** | **Other Mercury Sources** |
| Calero Reservoir | Arroyo Calero Creek[2], then Alamitos Creek | Canal from Almaden Reservoir (New Almaden Mining District) | Atmospheric deposition and background soil (nonurban stormwater runoff) |
| Almaden Reservoir[2] and tributaries | Alamitos Creek | New Almaden Mining District | Nonurban stormwater runoff |
| Alamitos Creek and tributaries | Alamitos and Guadalupe creeks join below Lake Almaden[2] to become the Guadalupe River | New Almaden Mining District and Almaden Reservoir; Santa Teresa and Bernal mercury mines | Nonurban and urban stormwater runoff |
| Guadalupe Reservoir and tributaries | Guadalupe Creek | New Almaden Mining District | Nonurban stormwater runoff |
| Guadalupe Creek and tributaries | Guadalupe River | New Almaden Mining District and Guadalupe Reservoir | Nonurban and urban stormwater runoff |
| Canoas Creek and tributaries | Guadalupe River | Hillsdale, Santa Teresa, and Bernal mercury mines | Nonurban and urban stormwater runoff |
| Guadalupe River and tributaries | South San Francisco Bay | Alamitos and Guadalupe creeks | Nonurban and urban stormwater runoff |

Notes:
[1] Includes tributaries to these waters, and percolation ponds along these waters
[2] Not yet listed as impaired (see Section 2.4).

| **Waters That Do Not Receive Mercury Mining Waste** | **Sources (no mining wastes)** |
|---|---|
| Los Gatos Creek downstream of Vasona Dam, including tributaries percolation ponds | Nonurban and urban stormwater runoff |
| Ross Creek | Nonurban and urban stormwater runoff |

The map in Figure 4.1 shows mining wastes discharged from the New Almaden Mining District in red, and urban stormwater runoff in brown. How these and other sources contribute to methylmercury production is an important concern, particularly in the dry season. Seasonal variations in source inputs and methylmercury production are discussed below.




## Figure 4.1 Locations of Primary Mercury Sources

*Citation: prepared by Tetra Tech under contract to Water Board*

The following sections (4.1 through 4.5) on wet season total mercury and dry season methylmercury loads are based on Section 4 of the *Final Conceptual Model Report* (Tetra Tech 2005c.) As described in Section 3 (Conceptual Model), the Santa Clara Valley Water District retained Tetra Tech, Inc., as technical consultants to develop the conceptual model of mercury in the Guadalupe River watershed. The mercury loading analysis presented in Sections 4.1 through 4.5 (below) was first presented in the *Data Collection Report* (Tetra Tech 2005a) and again in the *Final Conceptual Model Report* (Tetra Tech 2005c).

Tetra Tech's estimates are based on the assumption that whatever the source, once mercury enters the water column, most of it is bound to particles (see Section 6, Linkage Analysis). Therefore, the mercury loads can be quantified on the basis of sediment loads and mercury concentrations in suspended sediment (particulate mercury), as shown in Equation 4.1, which is used below to calculate the mining waste load.

Equation 4.1
Mercury Concentration in Water = (Particulate Mercury) x (Total Suspended Solids)

The following three equations are used in the methodology sections below to calculate each of the loads.

Equation 4.2
Daily Mercury Load = (Daily Flow) x (Mercury Concentration in Water)

Equation 4.3
Unit Area Mercury Load = (Seasonal Mercury Load) / (Representative Area)

Equation 4.4
Drainage Area Load = (Unit Area Mercury Load) x (Drainage Area)

Loads transported downstream from one water body to another can be estimated on the basis of mercury concentrations in water samples and flow volumes as shown in Equation 4.5.

Equation 4.5
Load of Mercury = (Volume of Water) x (Mercury Concentration in Water)

### 4.1 Methodology Overview: Wet Season Load Estimates

To develop the conceptual model, Tetra Tech assessed loads for the wet and dry seasons separately, based on the knowledge that most mercury transport occurs during the wet season, and most methylmercury production occurs during the warm, dry season. Tetra Tech focused a large part of the wet season data collection effort on measuring flow and mercury at different locations and different times in the watershed. Tetra Tech indirectly inferred loads transported from land surface to water from the measured concentrations, and from modeled and gaged flows in streams in the watershed. Using sub-watersheds affected principally by one source, they estimated the contribution of the wet season unit area for mining waste, urban stormwater runoff, and background (soil and atmospheric deposition) in units of micrograms of mercury per square meter of land surface ($\mu g/m^2$). Tetra Tech also indirectly inferred loads from multiple sources transported downstream (i.e. from one water body to another) by relationships between flow and concentrations of total mercury, dissolved mercury, and methylmercury, in units of grams per day (g/d).

For the warm, dry season, Tetra Tech focused sampling efforts on measuring mercury at different depths in the two reservoirs most affected by mining (Almaden and Guadalupe). Typical of large, deep water bodies, these two reservoirs undergo thermal stratification in the dry season. Stratification results in an upper warm layer (epilimnion), a cool lower layer (hypolimnion), and a transitional zone between them (thermocline). Depth measurements from surface to thermocline, and from thermocline to bottom, coupled with bathymetry, yielded epilimnion and hypolimnion volumes over the dry season. Concentration, multiplied by volume, yields mass. The data were used to infer methylmercury production in units of g/d.

For the purpose of this analysis, Tetra Tech estimated all loads as net loads (sources minus losses) at the point of interest. Examples of losses include deposition of mercury-laden sediment on creek and river floodplains, banks, and bottoms; and photodemethylation. (Deposition may result in a temporary loss, as nearly all sediments are likely to be scoured and transported at a later date; photodemethylation of methylmercury to gaseous inorganic mercury may be a permanent loss, however, as the mercury can then be transported out of the watershed.)

#### *METHODOLOGY FOR MINING WASTE LOADS*

The mining waste load calculated herein includes mercury from three sources: mining waste, atmospheric deposition, and naturally occurring mercury in soil. The Los Capitancillos Creek watershed was used to estimate the unit area mining waste load using the following steps.

1) Select Representative Area
   Tetra Tech selected Los Capitancillos Creek to estimate the unit area mining waste load because its watershed is almost entirely within the New Almaden Mining District.

2) Collect Available Data on Flows, Total Suspended Solids, and Mercury
   In developing this load, Tetra Tech had little actual flow data to draw on. There are no flow gages in the New Almaden Mining District. In the absence of actual data, Tetra Tech used a hydrologic model to estimate daily wet season flows in creeks draining the mining district. This model, called the Soil and Water Assessment Tool Version 2000 (SWAT 2000), was developed by the U.S. Department of Agriculture, Agricultural Research Service, and the Texas A&M Spatial Sciences Laboratory (Tetra Tech 2005a). SWAT is a long-term, continuous watershed simulation model. Widely used in the United States, this model simulates land cover impacts together with weather, soil, topography, and vegetation data. Because of the absence of flow gage information at any of the subwatersheds modeled, the SWAT model could not be calibrated, which is considered a source of uncertainty (see Section 4.3).

   Data on total suspended solids and mercury in Los Capitancillos Creek were collected on two dates: March 3 and 26, 2004. Because this is such a small data set, Tetra Tech used total suspended solids and mercury data from all New Almaden Mining District creeks sampled in the wet season to undertake the next steps in developing the mining waste loads (see “creeks draining historic mercury mining areas" section of Table 6-1 in *Data Collection Report* (Tetra Tech 2005a)). These district-wide samples were collected from March 2 to April 23, 2004. However, the last large storm (and high creek flow) of the season occurred in late February. Lack of high flow sample data may lead to an underestimation of the load, which is discussed in the uncertainty section (4.3), below.

3) Relate Flow to Total Suspended Solids
Tetra Tech developed a linear regression relationship between daily modeled flow for Los Capitancillos Creek and available total suspended solids data from all creeks in the mining district; see Figure 6-1 in *Data Collection Report* (Tetra Tech 2005a). This regression was applied to the modeled daily flows to estimate daily total suspended solids concentrations in the creek. Because data was only available from smaller storms, the regression was applied to higher creek flows than those sampled (i.e., extrapolated beyond the data set). This source of uncertainty in the load estimates is discussed in Section 4.3, below. Additionally, as noted by City of San Jose staff, "other factors strongly affect the mobilization of sediments in streams, such as short-term rainfall intensity and timing. Stormwater in particular often has higher TSS earlier in a storm, even when flows remain constant or increase later in the storm (first flush phenomenon)" (Osborn 2006).

4) Relate Total Suspended Solids to Total Mercury
The average particulate mercury concentration in creeks in the New Almaden Mining District in these 2003-2004 wet season samples was 17.5 milligrams of mercury per kilogram of soil (mg/kg, parts per million), see Table 4.2. From Equation 4.1, average particulate mercury multiplied by estimated daily total suspended solids (from Step 3), yields estimated average daily total mercury concentrations.

5) Relate Total Mercury to Dissolved Mercury and Methylmercury
Tetra Tech developed linear regression relationships between estimated concentrations of total mercury (from Step 4) and both dissolved mercury and methylmercury; see Figure 6-5 in *Data Collection Report* (Tetra Tech 2005a). These regressions were applied to the estimated daily total mercury (from Step 4) to estimate daily concentrations of dissolved mercury and methylmercury.

6) Calculate Wet Season Unit Area Loads
Loads are developed by multiplying flow by mercury concentration (Equation 4.2). Modeled daily flow (from Step 2), multiplied by estimated daily concentrations of total mercury (from Step 4) and dissolved mercury and methylmercury (from Step 5), yields daily loads. The sum of the product of daily loads yields the seasonal load for each type of mercury measured: total mercury, dissolved mercury, and methylmercury. The unit area mining waste load was calculated (see Equation 4.3) by dividing the seasonal load (for total mercury, dissolved mercury, and methylmercury) by the area of the Los Capitancillos Creek watershed, yielding a unit area mining waste load of 54.5 $\mu g/m^2$ for total mercury, 14.8 $\mu g/m^2$ for dissolved mercury, and 0.11 $\mu g/m^2$ for methylmercury in the 2003-2004 wet season.

Based on the methodology above, the 2003-2004 wet season unit area loads developed for Los Capitancillos Creek are more than 40 times greater than background total and dissolved mercury loads, and about 10 times greater than background methylmercury loads.

In the load diagrams in Section 4.2 (Figures 4.2 through 4.4), arrows pointing to (not between) each water body indicate loads calculated from Equation 4.4. (Arrows pointing from one water body downstream to the next are discussed below in "Methodology for Loads Transported Downstream"). Each drainage area is assigned a type (mines, urban stormwater runoff, or background), and its area multiplied by its unit area load. These drainage area loads come from multiple sources, which are indicated where applicable. For example, in Figure 4.2 a large portion of the New Almaden Mining District, which drains to Alamitos Creek between the reservoir and Calero Creek, contributed an estimated load of 120 grams of mercury from mining waste, atmospheric deposition, and naturally occurring mercury in soil. In this same wet season, the area on the opposite side of Alamitos Creek contributed an estimated load of 9.6 grams from background sources (atmospheric deposition and naturally occurring mercury in soil), and 1.7 grams from urban sources as discussed at the end of "methodology for urban stormwater runoff loads."

**Table 4.2 Mining Waste Particulate Mercury**

| Sample ID | Total Suspended Solids (TSS; mg/l) | Particulate Mercury (ng/g) | Particulate Mercury (mg/kg) |
|---|---|---|---|
| *Citation: Table 3-3 (Tetra Tech 2005a)* | | | |
| Mine Hill Tributaries | | | |
| E1-6 | 2.4 | 30,000 | |
| E1-7 | 0.4 | 62,000 | |
| E1-7 | 0.4 | 47,000 | |
| North Los Capitancillos Creek | | | |
| E1-9 | 3.2 | 2,200 | |
| E1-9A | 18.9 | 1,400 | |
| E1-9B | 18.4 | 630 | |
| *Citation: Table 3-10 (Tetra Tech 2005a)* | | | |
| Deep Gulch Creek | | | |
| E2-8 | 1.1 | 7,200 | |
| Greystone Creek | | | |
| E2-15 | 2.8 | 7,800 | |
| Randol Creek | | | |
| E2-16 | 1.1 | 1,200 | |
| Average: | | 18,000 | 18 |

#### METHODOLOGY FOR URBAN STORMWATER RUNOFF LOADS

The load calculated herein includes mercury from three sources: urban stormwater runoff, atmospheric deposition, and naturally occurring mercury in soil. The Ross Creek watershed was used to estimate the unit area urban stormwater runoff load using the following steps:

1) Select Representative Area
Tetra Tech selected the Ross Creek watershed to estimate the unit area urban stormwater runoff load because this watershed is almost entirely urbanized and has no history of mining activities.

2) Collect Available Data on Flows, Total Suspended Solids, and Mercury
Tetra Tech obtained wet weather daily flows from the gage near the downstream end of Ross Creek, but little data on total suspended solids and mercury in the creek was available. Because this is such a small data set, Tetra Tech added total suspended solids and mercury data from other creeks draining similar urban areas, and with no mining history, to its limited data from Ross Creek to develop the waste loads for urban stormwater runoff (see Table 6-1 in *Data Collection Report* (Tetra Tech 2005a). The samples were collected from a wide range of storm and flow events from February 27 to April 20, 2004.

3) Relate Flow to Total Suspended Solids
This is the same as step 3 for mining waste; Tetra Tech developed a linear regression relationship between daily measured flow and available total suspended solids data (see Figure 6-1 in *Data Collection Report* (Tetra Tech 2005a)). This regression was applied to the measured daily flows to estimate daily total suspended solids concentrations.

4) Relate Total Suspended Solids to Total Mercury
Tetra Tech developed a linear regression relationship between daily estimated total suspended solids and measured total mercury (see Figure 6-4 in *Data Collection Report* (Tetra Tech 2005a)). This regression was applied to estimated daily total suspended solids concentrations (from Step 3) to estimate daily total mercury concentrations.

5) Relate Total Mercury to Dissolved Mercury and Methylmercury
This is the same as step 5 for mining waste; Tetra Tech developed linear regression relationships between measured concentrations of total mercury and both dissolved mercury and methylmercury (see Figure 6-5 in *Data Collection Report* (Tetra Tech 2005a)). These regressions were applied to estimated daily total mercury (from Step 4) to estimate daily concentrations of dissolved mercury and methylmercury.

6) Calculate Wet Season Unit Area Loads
Loads are developed by multiplying flow by mercury concentration (Equation 4.2). Measured daily flow (Step 2), multiplied by estimated daily concentrations of total mercury (Step 4) or dissolved mercury and methylmercury (Step 5) yields daily loads. The sum of the product of daily loads yields the seasonal loads for total mercury, dissolved mercury, and methylmercury, respectively. Tetra Tech calculated the unit area urban stormwater runoff load

using Equation 4.3 by dividing the seasonal load (for total mercury, dissolved mercury, and methylmercury) by the area of the Ross Creek watershed, yielding unit area urban stormwater runoff loads of 1.6 $\mu g/m^2$ for total mercury, 0.61 $\mu g/m^2$ for dissolved mercury, and 0.02 $\mu g/m^2$ for methylmercury.
These total mercury load estimates are at the low end of published values, according to a cursory literature review by Lester McKee, scientist at San Francisco Estuary Institute (SFEI 2006). Dr. McKee stated that total mercury "unit loads from urban areas could be between 1-24 $ug/m^2/y$ and most typically 3-5 $ug/m^2/y$."

Tetra Tech multiplied these unit area loads by the corresponding urban drainage area (Equation 4.4) to calculate the estimated urban stormwater runoff loads discharged to creeks below reservoirs, urban creeks (Canoas and Ross creeks), and the Guadalupe River. By comparing the background (below) and urban stormwater runoff unit area total mercury loads of 1.16 and 1.6 $\mu g/m^2$ respectively in 2003-04 wet season, it appears that urban sources contributed about 25 percent of the total mercury load from urbanized areas, while the remaining 75 percent came from atmospheric deposition and naturally occurring mercury in soil. However, this method underestimates the urban stormwater runoff contribution because it does not account for first flush mercury loads in urban stormwater runoff, which are significant (Soller et al. 2003).

In the load diagrams in Section 4.2 (Figures 4.2 through 4.4), each drainage area is assigned a type (mines, urban stormwater runoff, or background), and its area multiplied by its unit area load. These drainage area loads are from multiple sources, which are indicated where applicable. For example, in Figure 4.2, the urbanized portion of the Alamitos Creek subwatershed between the reservoir and Calero Creek contributed an estimated load of 1.7 grams of mercury in the 2003-2004 wet season from urban stormwater runoff, atmospheric deposition, and naturally occurring mercury in soil. In this same wet season, the rural portion of this subwatershed outside of the New Almaden Mining District contributed an estimated load of 9.6 grams from background sources (atmospheric deposition and naturally occurring mercury in soil).

#### *METHODOLOGY FOR BACKGROUND LOADS*

The background load was calculated in a manner similar to that for the urban stormwater runoff load. The background load is from two sources: naturally occurring mercury in soil and atmospheric deposition. The Soda Spring watershed was used to estimate the unit area background load using the following steps:

1) Select Representative Area
   Tetra Tech selected the Soda Spring watershed to estimate the unit area background load because this watershed has practically no development and no mercury mines.

2) Collect Available Data on Flows, Total Suspended Solids, and Mercury
   Little flow, total suspended solids, and mercury data currently exists for background areas, where no gages have been installed to date. Therefore, Tetra Tech estimated daily wet season flows in Soda Spring using the SWAT 2000 model (see "Methodology for Mining Waste Loads" above). Tetra Tech then added total suspended solids and mercury data from other creeks draining similar

undeveloped background areas and with no mining history to its limited data from Soda Spring to develop the background load (see Table 6-1 in *Data Collection Report* (Tetra Tech 2005a)). The samples were collected from March 2 to April 14, 2004. However, the last large storm (and high creek flow) of the wet season occurred in late February. Lack of high flow sample data is discussed in the uncertainty section (4.3) below.

3) Relate Flow to Total Suspended Solids
This is the same as step 3 for mining waste and urban stormwater runoff; Tetra Tech developed a linear regression relationship between daily modeled flow and available total suspended solids data (see Figure 6-1 in *Data Collection Report* (Tetra Tech 2005a)). This regression was applied to the modeled daily flows to estimate daily total suspended solids concentrations. Because data was only available from smaller storms, the regression was applied to higher creek flows than were sampled (i.e., extrapolated beyond the data set). This source of uncertainty in the load estimates is discussed in Section 4.3 below.

4) Relate Total Suspended Solids to Total Mercury
This is the same as step 4 for urban stormwater runoff; Tetra Tech developed a linear regression relationship between daily estimated total suspended solids and measured total mercury (see Figure 6-4 in *Data Collection Report* (Tetra Tech 2005a)). This regression was applied to the estimated daily total suspended solids concentrations (from Step 3) to estimate daily total mercury concentrations.

5) Relate Total Mercury to Dissolved Mercury and Methylmercury
This is the same as step 5 for mining waste and urban stormwater runoff; Tetra Tech developed linear regression relationships between measured concentrations of total mercury and both dissolved mercury and methylmercury (see Figure 6-5 in *Data Collection Report* (Tetra Tech 2005a)). These regressions were applied to the estimated daily total mercury (from Step 4) to estimate daily concentrations of dissolved mercury and methylmercury.

6) Calculate Wet Season Unit Area Load
Loads are developed by multiplying flow by mercury concentration (see Equation 4.2). Modeled daily flow (Step 2), multiplied by estimated daily concentrations of total mercury (Step 4) or dissolved mercury and methylmercury (Step 5) yields daily loads. The sum of the product of daily loads yields the seasonal loads for total mercury, dissolved mercury, and methylmercury. The unit area background load was calculated (Equation 4.3) by dividing the seasonal loads (total mercury, dissolved mercury, and methylmercury) by the area of the Soda Spring watershed, yielding unit area background loads of 1.16 $\mu g/m^2$ for total mercury, 0.33 $\mu g/m^2$ for dissolved mercury, and 0.012 $\mu g/m^2$ for methylmercury.

Rainfall in the vicinity of Lexington Reservoir (including Soda Spring) was approximately 30 inches from October 2003 through May 2004. The background unit area loads were scaled proportionally to the amount of rainfall in each location, which was as high as 48 inches in the headwaters above Guadalupe and Almaden reservoirs. Tetra Tech multiplied the resulting unit area loads by each drainage area (Equation 4.4) to calculate the estimated background (soil and atmospheric deposition) loads discharged to each water body in the watershed.

#### *METHODOLOGY FOR LOADS TRANSPORTED DOWNSTREAM*

Tetra Tech estimated loads from multiple sources transported downstream from one water body to another using daily gaged flow and measured concentrations of total mercury, dissolved mercury, and methylmercury (Equation 4.5). Linear regressions were developed using gaged flow and measured mercury concentrations. These were applied to the daily wet season flows to estimate daily total mercury, dissolved mercury, and methylmercury concentrations. Daily flow, multiplied by daily concentrations, yields daily loads which were summed to arrive at the seasonal total load.

By design, reservoirs contain a substantial amount of storage, and because their outflows are controlled, it is likely that mercury concentrations in their outlets are less variable than in creeks, especially during the wet season. For this reason, loads discharged from reservoirs were computed in a manner simpler than that applied to streams: Gaged outflows were multiplied by the wet season average mercury concentration.

An exception was made for transport from Almaden Reservoir to Calero Reservoir because, unlike the other discharges, the canal flows only part of the time. Tetra Tech multiplied the average daily wet season flow of 7.1 cubic feet per second (cfs) by the average concentration (measured at the outlet of the Almaden-Calero Canal) to obtain the estimated seasonal load of total mercury, dissolved mercury, and methylmercury.

#### *ATMOSPHERIC DEPOSITION LOADS*

As mentioned above, loads from atmospheric deposition are included in the background loads. Tetra Tech provided the following information regarding atmospheric deposition in Section 4.1.1 of the *Final Conceptual Model Report* (Tetra Tech 2005c). Atmospheric deposition includes wet and dry deposition, and transport of past dry deposition in stormwater runoff from land surface to water bodies. Tetra Tech estimated the atmospheric deposition input of total mercury as a daily load using wet and dry deposition data collected by the San Francisco Estuary Institute (SFEI) at various locations around San Francisco Bay. Tetra Tech estimated wet deposition using a rainfall concentration of 9.7 nanograms of mercury per liter of water (ng/l), a rainfall amount of 48 inches in the watersheds above the reservoirs, and a rainfall amount of 14 inches for the rest of the watershed. Annual wet deposition was estimated as 12 micrograms per square meter per year ($\mu g/m^2/yr$) in the upper watershed, and 3.4 $\mu g/m^2/yr$ in the lower watershed. The annual dry deposition was estimated as 19 $\mu g/m^2/yr$ throughout the system. Thus, the total deposition is approximately 30 $\mu g/m^2/yr$.

Tetra Tech noted that only a small portion (about 5 percent as supported by recent literature review) of atmospheric deposition is exported from land into waters. Tetra Tech rounded the estimated background unit area load of total mercury to one significant digit, 1 $\mu g/m^2$, which is 3 percent of the 30 $\mu g/m^2/yr$ from atmospheric deposition. The background unit area load includes mercury from two sources: atmospheric deposition and naturally occurring mercury in soil. It is not possible from this data set to determine what proportion of the background load is from atmospheric deposition.

## 4.2 2003-2004 Wet Season Loads

This section is taken from Section 4.3 of the *Final Conceptual Model Report* (Tetra Tech 2005c). Total mercury, methylmercury, and dissolved methylmercury wet season loads from October 1, 2003, through May 31, 2004, for the major water bodies in the Guadalupe River watershed are shown in graphic form in Figures 4.2 through 4.4. The wet season loads were calculated for the following sources: background (naturally occurring mercury in soil and atmospheric deposition combined), mines (mining waste, naturally occurring mercury in soil, and atmospheric deposition combined), and urban (urban stormwater runoff, naturally occurring mercury in soil, and atmospheric deposition combined). Not every source contributes to every water body (e.g., mining wastes discharged from the New Almaden Mining District are shown in red on Figure 4.1).

For total mercury loads, shown in Figure 4.2 and Table 4.3, all reservoir outflows appear to be of roughly the same magnitude, except Calero Reservoir. Although concentrations flowing out of Lexington Reservoir are lower than from Guadalupe and Almaden reservoirs, the low concentration is counterbalanced by the substantially larger volume of outflows, which results in nearly equal loads from Lexington Reservoir outside the mining district as compared to the two reservoirs (Guadalupe and Almaden) immediately downstream from the mining district.

Farther downstream, the largest loads to Guadalupe River originate from Alamitos Creek, followed by Los Gatos and Guadalupe creeks. Alamitos Creek loads, upstream of Calero Creek, are substantially higher than Almaden Reservoir outflow loads, indicating the mobilization of internal sediment loads. Although the Los Gatos Creek watershed does not contain any mines, the relatively high loads are a consequence of its larger watershed, and therefore larger background load, compared to Guadalupe Creek.

The 2003-04 wet season loads exiting the Guadalupe River to San Francisco Bay (10,000 g) are far higher than the total loads entering the river from all its tributary creeks and from its watershed (800 g). This is a strong indication of uncertainties in the upstream contributing loads, in loads from the highly urbanized area, and in the mobilization of internal sediment loads. Uncertainties in loads are discussed in more detail below.

**Table 4.3 Wet Season Total Mercury Loads (10/01/03 – 05/31/04)**

| Sources | Annual Load (g) | Total Annual Load (g) | Uncertainty |
|---|---|---|---|
| Mining waste (includes atmospheric deposition and naturally occurring mercury in soil) | | | |
| New Almaden Mining District (NAMD) [1] Creeks Draining to Guadalupe Reservoir | 220 | | +120% to +500% [3, 4] |
| NAMD Creeks Draining to Almaden Reservoir [2] | 190 | | +120% to +500% [3, 4] |
| NAMD Creeks Below Reservoirs | 465 | | Not estimated |
| Total | | 875 | +120% to +300% |
| Urban stormwater runoff, atmospheric deposition, and naturally occurring mercury in soil | | | |
| NAMD Creeks Below Reservoirs | 27 | | |
| Urban Creeks | 115 | | [5] |
| Guadalupe River | 89 | | [6] |
| Total | | 231 | Not estimated |
| Background (atmospheric deposition and naturally occurring mercury in soil) | | | |
| NAMD Creeks Draining to Guadalupe Reservoir | 20 | | +120% to +500% [3] |
| NAMD Creeks Draining to Almaden Reservoir | 28 | | +120% to +500% [3] |
| Calero Reservoir | 14 | | +120% to +500% [3] |
| Lexington Reservoir | 110 | | +120% to +500% [3] |
| NAMD Creeks Below Reservoirs | 45 | | Not estimated |
| Urban Creeks | 62 | | Not estimated |
| Guadalupe River | 41 | | [6] |
| Total | | 320 | +120% to +300% |

Notes:

1) A substantial portion of the mining waste load to reservoirs is accumulated as sediment in the reservoirs; in the 2003-2004 wet season exports from Guadalupe and Almaden reservoirs to NAMD creeks below reservoirs were 150 g and 110 g, respectively.

2) 190 g of mercury were transported from Almaden Reservoir via the Almaden-Calero Canal to Calero Reservoir; 28 g were exported from Calero Reservoir to Calero Creek.

*Notes to Table 4.3 continued on next page*

3) The load estimates for the upper watershed are biased low because they are based on sampling conducted during small storm events. Infrequent high-rainfall-intensity storms result in much higher loads. Based on stormwater sampling results from Almaden Quicksilver County Park on February 25, 2004, the mercury load to Guadalupe Reservoir was 490 g in one day, nearly twice the estimated annual total of 220 g (+120%). Using our professional judgment, together with higher rainfall amounts earlier in the season, Water Board staff estimates the total annual load from the upper watershed is biased as much as 500% low.

4) The dissolved mercury load estimates are based on sampling conducted during small storm events. Dissolved mercury in samples from NAMD creeks ranged from 15 percent to 60 percent of total mercury. However, in a large storm event on February 25, 2004, dissolved mercury ranged from 0.4 percent to 12 percent in stormwater samples from Almaden Quicksilver County Park (see calculation in Appendix B).

5) The load estimates for urban stormwater runoff did not include samples from storm drains. Mercury concentrations in urban creeks ranged from 2.0 to 29.8 ng/l, and in Guadalupe River ranged from 14.5 to 464.4 ng/l (TetraTech 2005a). Mercury concentrations in samples from storm drains collected between 1997-1999 ranged from 23 to 1,370 ng/l (Soller et al. 2003).

6) For a discussion of uncertainty in estimates of mercury load in the Guadalupe River transported past Highway 101 see *Range in Loads to San Francisco Bay*, below in Section 4.3, *Range in 2003-2004 Wet Season Load Estimates*.

For methylmercury loads, shown in Figure 4.3, Guadalupe Reservoir (1.4 g) is the largest contributor in the wet season, followed by Lexington and Almaden reservoirs at somewhat lower levels, with Calero Reservoir (0.3 g) being the lowest. Farther downstream, with the exception of Alamitos Creek (2.0 g), the methylmercury loads to the Guadalupe River from the different creeks are not too dissimilar (0.5 – 1.0 g), indicating that even small amounts of total mercury can produce substantial amounts of methylmercury if the right aquatic chemistry conditions are present. As with total mercury, the methylmercury loads exiting the Guadalupe River to San Francisco Bay (27 g) are somewhat higher than the total loads (6.7 g) entering the river from all its tributary creeks and from its watershed.

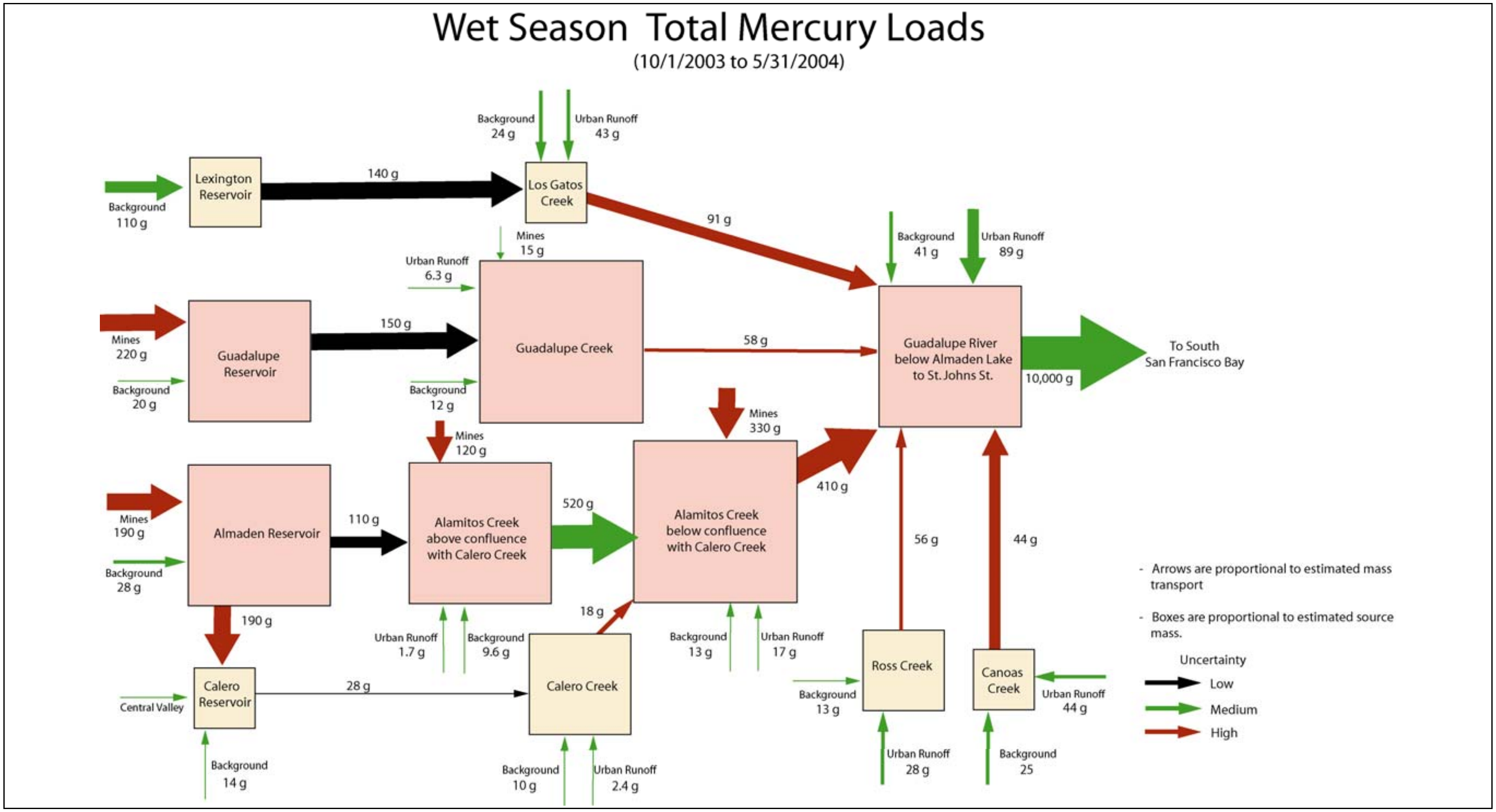



**Figure 4.2 Wet Season Total Mercury Loads**

*Citation: Figure 4-1 in Final Conceptual Model Report (Tetra Tech 2005c)*

Thicker arrows indicate greater loads of mercury. High uncertainty in the loads from mines (red arrows) is due to sampling during small storm events.

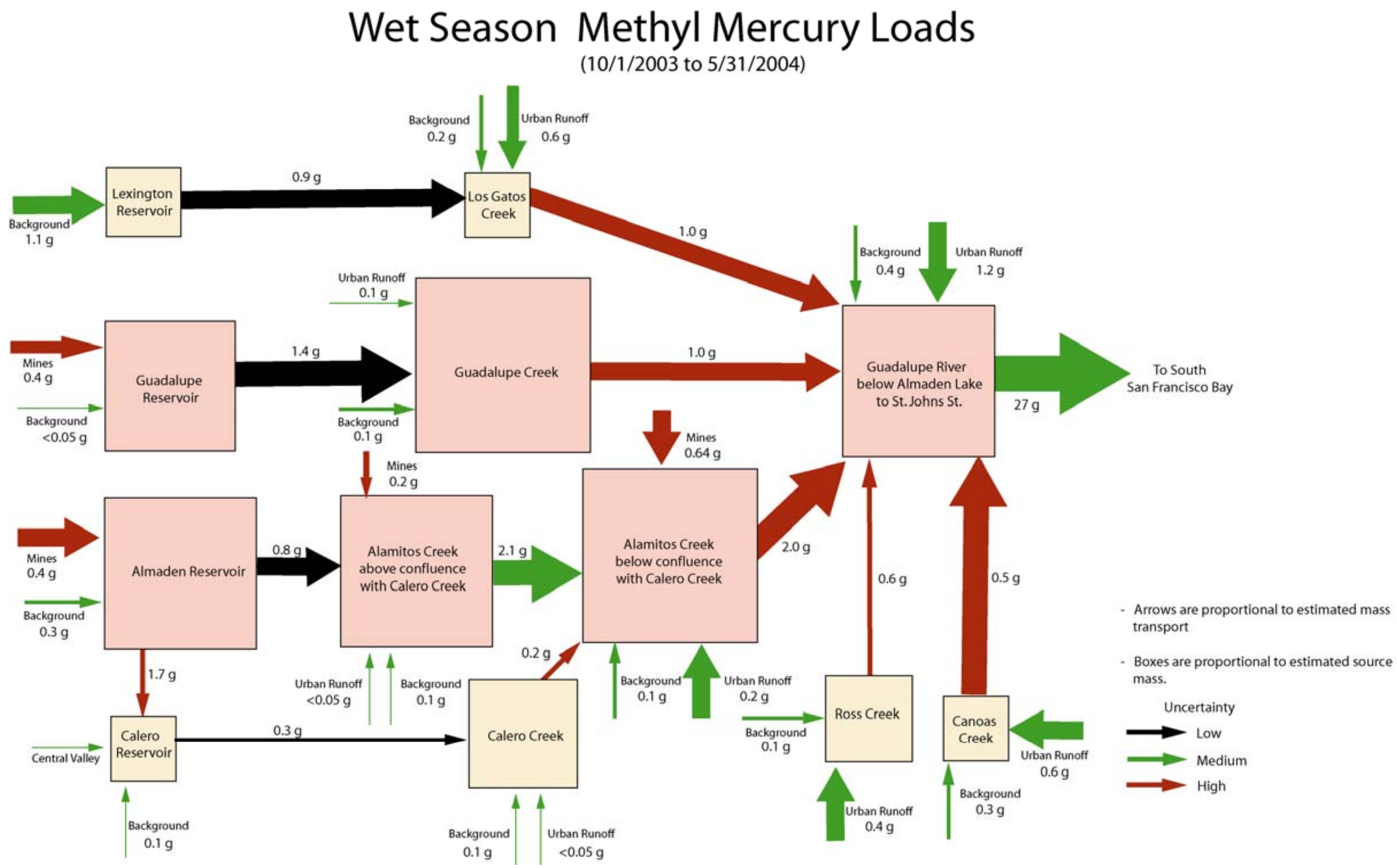



**Figure 4.3 Wet Season Methylmercury Loads**

*Citation: Figure 4-3 in Final Conceptual Model Report (Tetra Tech 2005c)*

Methylmercury loads in the wet season are about 100 times smaller than loads of total mercury (see Figure 4.2).

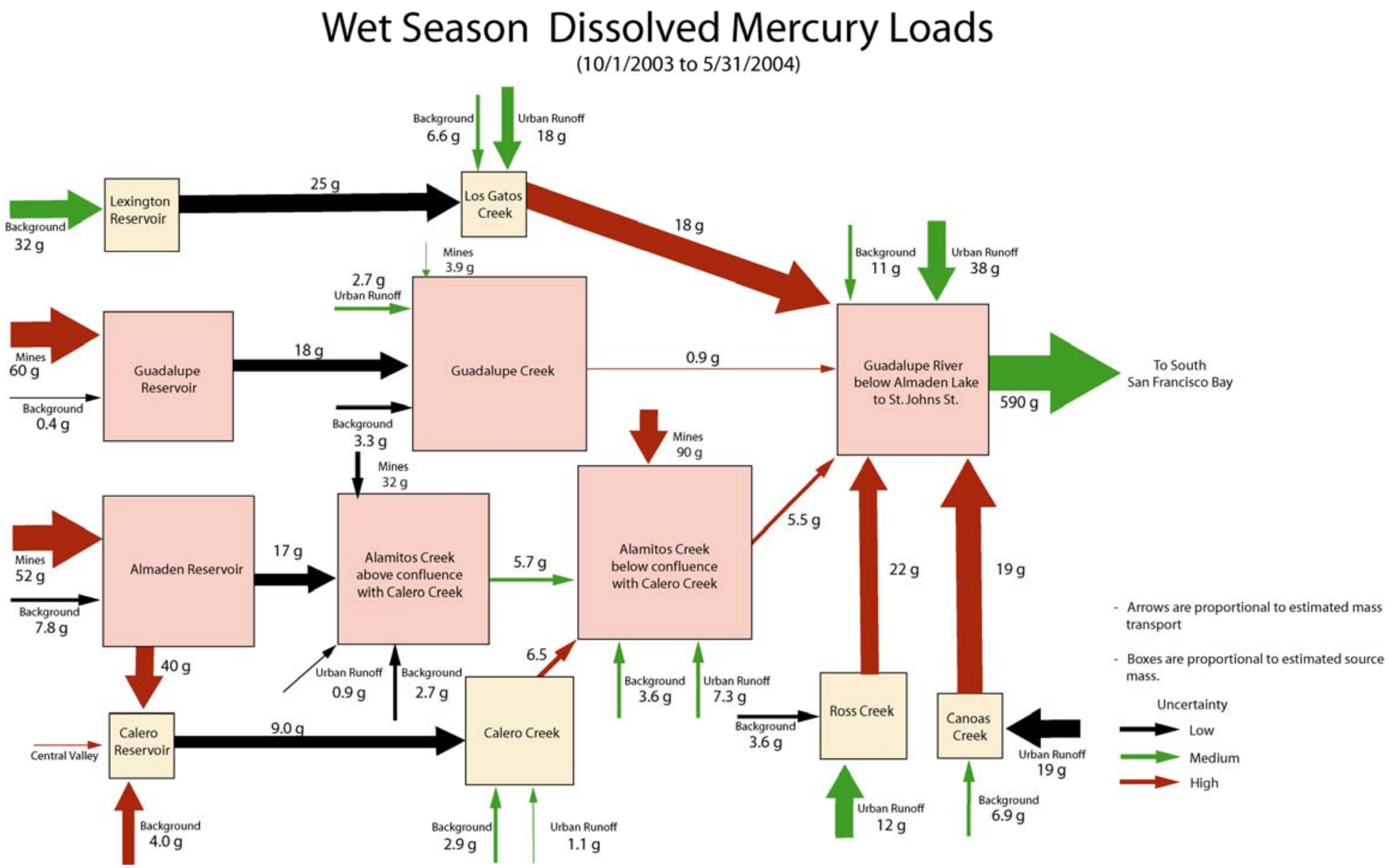



**Figure 4.4 Wet Season Dissolved Mercury Loads**

*Citation: Figure 4-2 in Final Conceptual Model Report (Tetra Tech 2005c)*

Dissolved mercury loads in the wet season are also much smaller than loads of total mercury (see Figures 4.2 and 4.3). These dissolved mercury load estimates are based on small storm events which have higher proportions of dissolved mercury than in large storm events which transport much more mercury.

### 4.3 Range in 2003-2004 Wet Season Load Estimates

Loads of contaminants over defined time periods are generally obtained as a product of the flow volumes and the concentrations. The loads are estimated rather than exact because there is inherent variability in the sampling and measuring techniques. Therefore, it is common practice to describe the range (i.e., uncertainty) in the load estimates.

When both flow and concentrations are highly variable over short durations, as is the case during storm events in the Guadalupe River watershed, accurate load estimates require very frequent sampling. Although there was a large effort to obtain mercury and flow data throughout the watershed in the wet season for purposes of mercury sampling for the TMDL, the data are still not sufficient to precisely quantify the loads at all locations sampled, i.e., define the average loads and the variability associated with each load. Therefore, the numerical values of the loads presented in this section are best considered only as estimates useful in comparing the relative magnitudes of different sources in the watershed. For example, from Table 4.3, we can see that the load of mercury from mining waste (875 g) is much greater than the mercury load from other sources (231 and 320 g, respectively, for urban stormwater runoff and background).

To facilitate interpretation of the data, Tetra Tech classified the uncertainty in the estimated loads into three categories (see Figures 4.2, 4.3, and 4.4):

- **High Uncertainty:** when flow data were limited to field estimates of creek flow at the time mercury samples were collected, and calculations were based on modeled flow
- **Medium Uncertainty:** when continuously gaged flow data were available
- **Low-Medium Uncertainty:** when continuously gaged flow *and* continuous turbidity data were available

Lower Guadalupe River load estimates fell into the low-medium uncertainty category because of the presence of a multi-decade continuous flow record and an independent station where the San Francisco Estuary Institute conducted monitoring for total suspended solids (continuous turbidity monitoring) and mercury (grab samples).

#### RANGE IN UPPER WATERSHED LOAD ESTIMATES

The upper watershed background and mining waste loads fell into the high uncertainty category because most 2003-2004 wet season samples were collected after the last large storm event in late February 2004. This precluded high flow sampling in the upper watershed. Figure 4.5 provides an illustration of precipitation and sampling events in the upper watershed area draining to Guadalupe Reservoir. The loads presented above must be considered in light of these constraints in the existing data set. As a general rule, increased flows result in higher suspended solids and, therefore, higher mercury transport. This process was accounted for by using flow-total suspended solids correlations (linear regression) to estimate total suspended solids levels at flows higher than those physically sampled (i.e., extrapolated beyond the data set). It is highly likely that these correlations were not accurate, and perhaps underestimated the load, especially at higher flows. Additionally, because of the absence of flow gage information from any of the upper subwatersheds modeled, the SWAT model could not be calibrated. This lack of calibration adds to the uncertainty, and there is insufficient information to determine whether it might contribute to under- or overestimating the load.

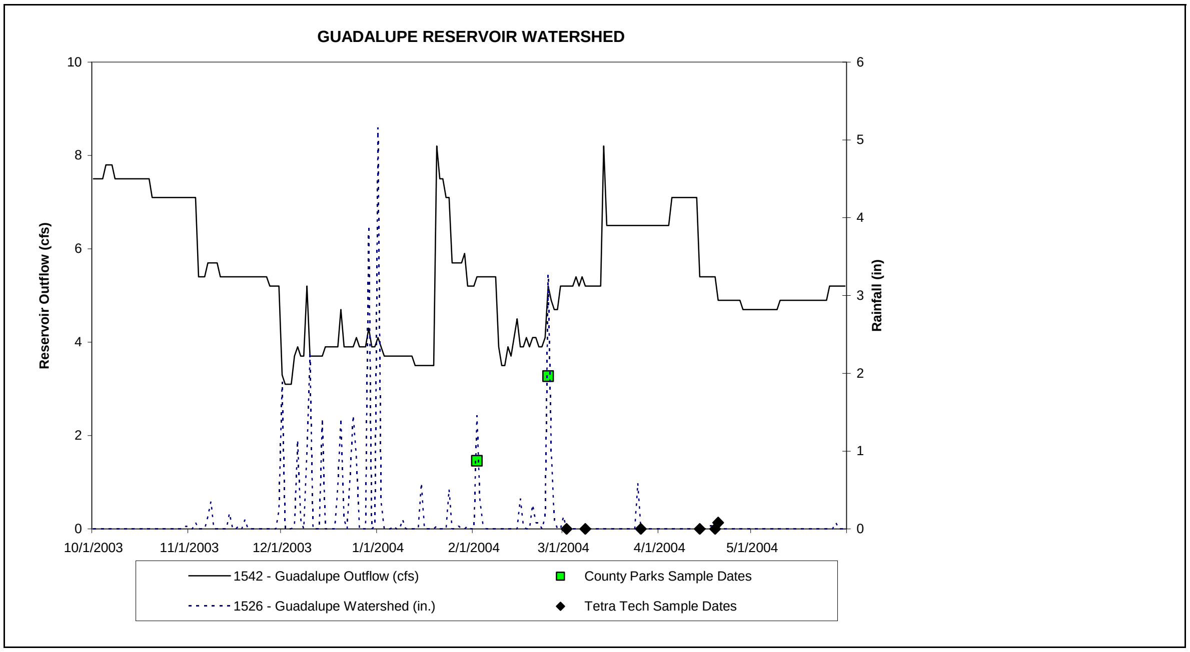



**Figure 4.5 Guadalupe Reservoir Outflows, Rainfall and Sample Dates**

Data from small storms ('Tetra Tech Sample Dates') was used to estimate mercury loads from the upper watershed, and data from a larger storm on February 25th for uncertainty analysis.

Calculations using data from the Almaden Quicksilver County Park illustrate the significance of high flow events with high total suspended solids. Measurements made at the park on Los Capitancillos Creek on February 25, 2004, indicated total suspended solids values of 8,890 mg/l, and mercury values of 5,300 ng/l, see Table 2-6 of the *Final Conceptual Model Report* (Tetra Tech 2005c). Flow measurements were not made during this sample collection event. However, based on modeled flow data computed using rainfall in the 2003-2004 wet season, the average estimated flow on this date is 58 cfs. Assuming that the peak flow is approximately four times the average daily flow, and that this flow lasts for four hours, the transported load from the Los Capitancillos Creek during this storm event is estimated to be 490 grams, a value much higher than the estimated annual load of mercury from mines to the Guadalupe Reservoir (220 grams).

Although approximate, this calculation highlights the significance of the storm event loads in the upper watershed, and indicates a major source of uncertainty in the estimated loads presented here: the contribution of large winter storms. Based on this assessment, it appears that the calculated loads presented here are more likely to be underestimates than to be overestimates. Dr. Lester McKee of the San Francisco Estuary Institute advises that peak flows for our San Francisco Bay systems are much greater than four times the average flow. He speculates that if the load estimate had taken sediment mobilization processes into account, rather than a linear regression relationship between daily modeled flow and available total suspended solids data, this may have resulted in loads 3 to 5, perhaps even 6, orders of magnitude greater than the estimates in the *Final Conceptual Model Report* (SFEI 2006). Tetra Tech strongly recommended further quantification of the upper watershed loads through additional wet weather data collection in future stages of this project. Tetra Tech also noted that the numerical values of the loads presented in this section are best considered only as estimates useful in comparing the relative magnitudes of different sources in the watershed. Water Board staff concurs that these load estimates are useful in comparing the relative loads from different sources and in different locations in the watershed, and do not currently anticipate a need for more precise load estimates from the upper watershed.

#### *RANGE IN LOADS TO SAN FRANCISCO BAY*

Tetra Tech sought to quantify the range in its load estimate of the total mercury entering San Francisco Bay from the Guadalupe River by accounting for the residual error in the regressions using Monte Carlo analysis. The analysis provides an estimate of the likely ranges of loads, given imperfect knowledge about the needed inputs, particularly flow-concentration relationships and inter-year variability in flows. Monte Carlo analysis is performed by assuming probability distributions for the key inputs, and performing the load calculations multiple times where values of inputs are drawn from a specified probability distribution. Each Monte Carlo trial results in an estimate of the load. When this process is repeated many times (typically several hundred or thousand times), a distribution of the loads is obtained that is consistent with the uncertainty in input parameters.

For the specific case of developing the uncertainty-based load estimates of mercury for the Guadalupe River watershed, where flows are related to total suspended solids, and the total suspended solids to mercury concentrations, a method was needed to provide probability distributions such that, given a specific value of flow, the method provides a probabilistic estimate of total suspended solids, and a probabilistic estimate of the total mercury concentrations. The method Tetra Tech used is a statistical approach that uses the residual errors in the regressions to develop Monte Carlo estimates of key input parameters.[1] This approach was implemented in Microsoft Excel, using the Crystal Ball program. Crystal Ball is a specialized tool for performing Monte Carlo simulations.

The Monte Carlo estimate of wet weather loads was computed using the following steps:

1) The flows, obtained from the USGS flow gage in the downstream portion of the Guadalupe River, were assumed to be accurately known, i.e., there was no uncertainty associated with them.
2) For a specific day, the flow rate was used to obtain a probabilistic estimate of the TSS using the regression equation for stations on the river, and using the statistical approach above.
3) Using the probabilistic estimate of TSS, a similar probabilistic estimate was obtained for total mercury concentration using the mercury-TSS correlation for the river stations.
4) Multiplying the flow and mercury concentration for each day provided an estimate of the daily load.
5) The entire wet weather load was calculated by summing the daily loads from October 1, 2003, to May 31, 2004.
6) Steps 1 through 5 were repeated 1,000 times to obtain a distribution of the wet weather load for 2004.

Steps 1 through 6 result in a quantitative estimate of uncertainty in the load in one wet season (October 2003 through May 2004). Daily average flows in this wet season ranged from 21 cfs to 1,730 cfs (Tetra Tech 2004b), and as described in Step 1, Tetra Tech made

[1] The statistical approach for doing this is to assume that the linear regression models developed by Tetra Tech are expressed as $y = \alpha + \beta x$, where $y$ is the dependent variable and $x$ is the independent variable, and $\alpha$ and $\beta$ are the intercept and slope. Using $N$ pairs of observed data $(X_i, Y_i)$, a least-squared error estimator was used to determine $\alpha$ and $\beta$. Our goal is to develop a Monte Carlo procedure that will generate random values of the dependent variable $y$ for specified values of the independent variable $x$. The variance of the model error will be computed using the $N$ data samples. An unbiased variance estimator $s_m^2$ is computed (Bhattacharyya & Johnson 1977, pages 341-357) as follows:

$$s_m^2 = \frac{SSE}{(N-2)}$$

where *SSE* is the residual sum of squares using *N* data pairs $(X_i, Y_i)$:

$$SSE = \sum_{i=1}^{N} (Y_i - \alpha - \beta X_i)^2 .$$

The Monte Carlo algorithm generates random deviates of the linear model by assuming the dependent $y$ variable of the model has Gaussian distribution $N(\mu_y, \sigma_y)$. The variance of the dependent $y$ variable is assumed to be the same for any value of the independent variable $x$. The j$^{th}$ deviate $y_j$ of the dependent variable can be generated for the specified dependent value $x^*$ as follows:

$$y^* = \alpha + \beta x^*, \text{ where } y_j \in N(y^*, s_m).$$

the reasonable assumption of no uncertainty in the flow measurement. Total suspended solids and mercury samples were collected between February 26 and April 20, 2004, with a maximum daily average flow of 851 cfs on February 26 (Tetra Tech 2004b). This was the fifth-highest average daily flow in this wet season. Consequently, there are no residual error values to estimate the uncertainty for the four days with highest flow. Because the largest loads of mercury occur with the highest flows, this quantitative estimate of uncertainty is biased low.

The Monte Carlo simulated distribution of wet season loads for 2003-2004 is shown in Figure 4.6. The distribution shows a somewhat skewed bell curve, with a longer tail on the right side than on the left side, as a consequence of some of the variables being log-transformed in the regressions. Total loads range from approximately 8 to 20 kg. The midpoint of the distribution is about 12 kg.

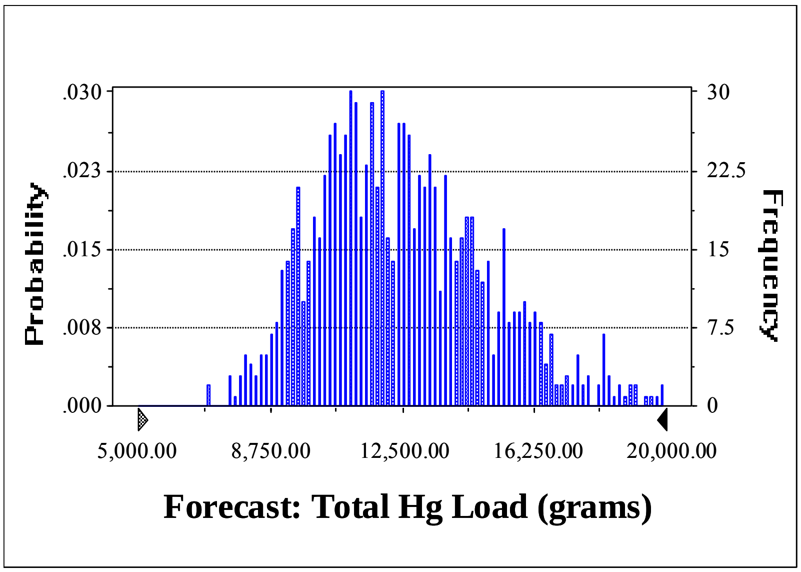



**Figure 4.6 Uncertainty in Single-Year Loads to South San Francisco Bay**

*Citation: Figure 4-7 in Final Conceptual Model Report (Tetra Tech 2005c)*
Loads of total mercury discharged from Guadalupe River to the Bay in 2004 estimated from a Monte Carlo simulation are 12 kg, with a range from 8 to 20 kg.

Although loads for a given year are uncertain, it is known that there is significant year-to-year variability in the flows out of the Guadalupe watershed. Because flows and mercury loads are related, it is likely that multi-year uncertainty will be significantly greater than the single-year uncertainty estimate. To assess the multi-year uncertainty, Tetra Tech performed a Monte Carlo analysis using daily average flows from 1960-2002 from the former USGS gaging station at St. John's Street. The maximum daily flow was 7,870 cfs. A single year (2004) from the new gaging station at California State Highway 101 was randomly sampled to compute total wet weather loads from October through May, during which the maximum daily flow was 1,730 cfs. The distribution of loads for the multi-year analysis is shown in Figure 4.7. It can be seen that the multi-year uncertainty is considerably greater than the single-year uncertainty, with values ranging from near zero for the extremely low flow years to almost 100 kg for the high flow years. Although this is not an unexpected result, the Monte Carlo analysis permits quantification of the process, and can be used to relate individual year loads, and potential load reductions, to the overall distribution of loads. Like the Monte Carlo simulation for one year, the Monte Carlo simulation for 1960–2001 wet seasons (Figure 4.7) is also biased low due to lack of data for high flow events, when the greatest loads occur.

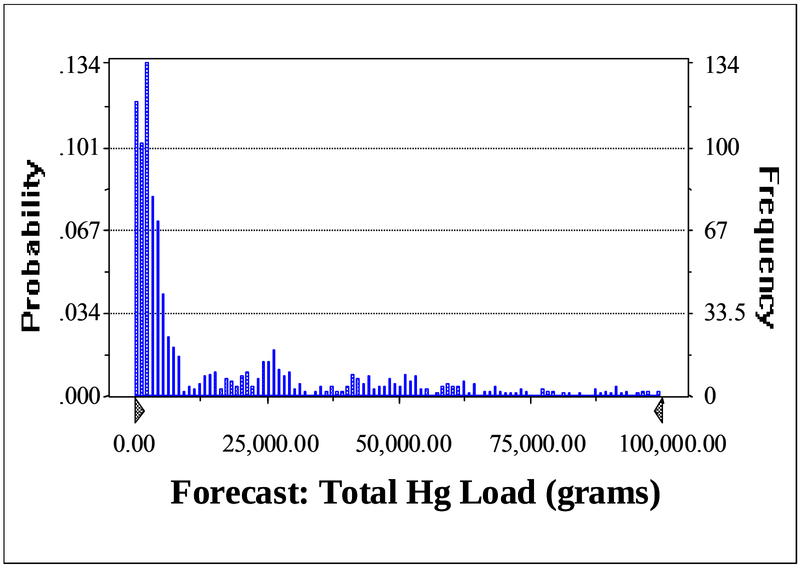



**Figure 4.7 Uncertainty in Multi-Year Loads (1960-2001) (Tetra Tech)**

*Citation: Figure 4-8 in Final Conceptual Model Report (Tetra Tech 2005c)*

Loads of total mercury discharged from Guadalupe River to the Bay for 1960–2001 estimated from a Monte Carlo simulation range up to 100 kg in high flow years.

The San Francisco Estuary Institute also developed a long-term load estimate, but using a different methodology. The San Francisco Estuary Institute methodology (McKee et al. 2004) has the benefit of being based on a continuous record of flow and turbidity for two entire wet seasons, including 22 sampling events during a range of storms compared to the three samples collected by Tetra Tech (Figure 4.8), only one of which characterized significant flow – albeit relatively small flow compared to the gauged record (see Figure 3.4). The wet season loads estimated between 1975 to 2001 and 2004 for the Tetra Tech and SFEI relationships are shown in Figure 4.9. Interestingly, the 2004 estimates are relatively similar (within a factor of two) given their different assumptions, methodologies and sample frequency. But, it is clear from these plots that continuous turbidity monitoring coupled with frequent grab samples which characterize a wide range of storms (SFEI) compared to infrequent grab sampling (Tetra Tech) makes a large difference in the estimates of mercury loads; the loads estimated using the SFEI approach are consistently higher (note log scale in Figure 4.9).

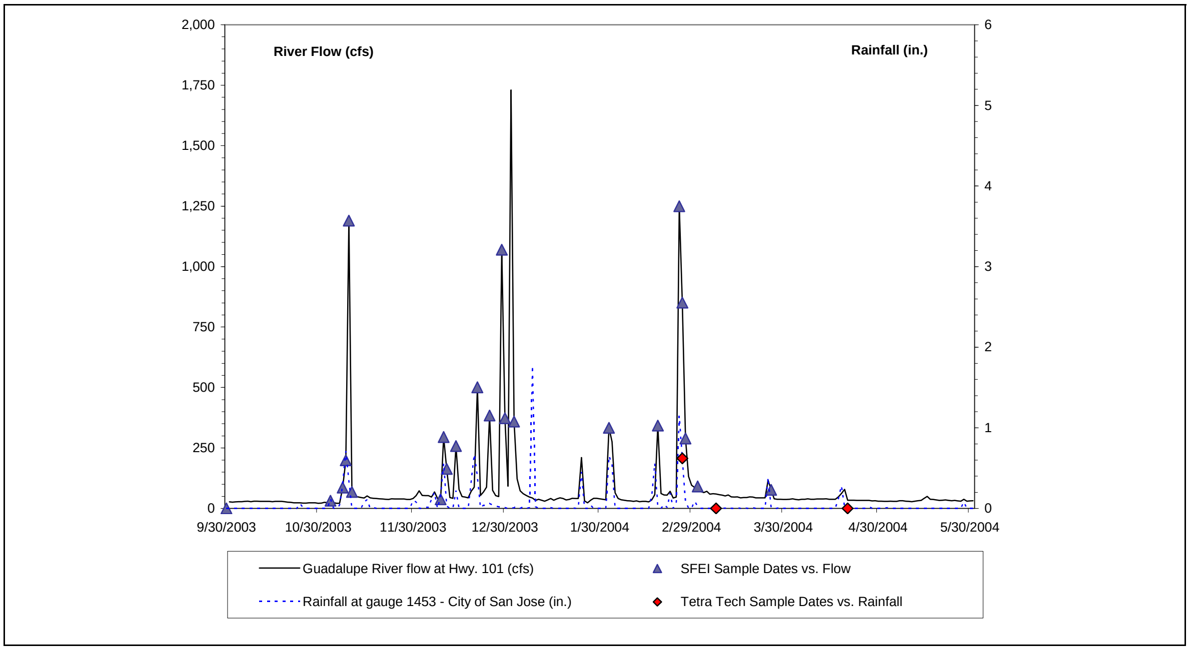



**Figure 4.8 Guadalupe River Wet Season Sample Dates at Highway 101**

Illustration of different methodologies: frequent samples over a range of storm sizes (SFEI) compared to few grab samples from small storms (Tetra Tech)

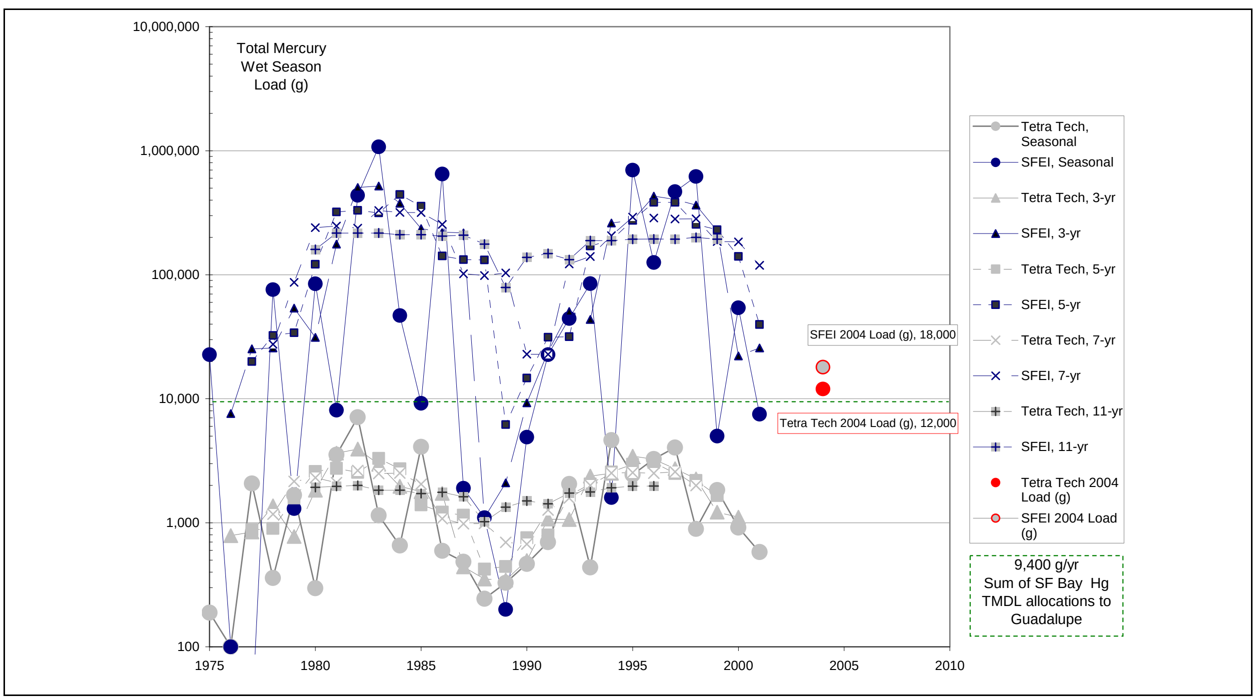



**Figure 4.9 Comparison of Uncertainty in Multi-Year Loads (1975-2001)**

*Citation: (Summers 2007, McKee 2007)*

The different methodologies (see Figure 4.8) make a large difference in the estimates of mercury loads (note log scale).

### 4.4 2004 Dry Season Methylmercury Loads

To estimate dry season loads of methylmercury, Tetra Tech used data from monthly to biweekly sampling of Almaden and Guadalupe reservoirs conducted between May and August, 2004. Load calculations considered the measured mercury concentrations and the reservoir-stored water volumes, both of which changed over time. Besides the mercury concentration data, other data required for the load calculations are the volumes of water stored in the reservoir in the hypolimnion and the epilimnion, and the outflows from the reservoirs. The depth of the hypolimnion was estimated from the temperature and dissolved oxygen profiles that were taken during the mercury sampling. The calculations of the hypolimnion and epilimnion volume were based on detailed bathymetric maps of the reservoirs. The reservoir-stored water volumes were obtained from automated gages that are associated with Santa Clara Valley Water District's online ALERT system. The concentrations over the sampling period were multiplied by the volume of the hypolimnion or the epilimnion to determine the mass of total or methylmercury in either compartment. Because concentration data were obtained less frequently than depth data, concentrations at dates without measurements were estimated by interpolation from the two nearest values with measurements.

The loads of mercury exported to Guadalupe Creek and Alamitos Creek were calculated as the product of mercury concentrations in the reservoir outflows and the flow rate data routinely collected by the Santa Clara Valley Water District and reported on the ALERT system. Daily average flow data were used (computed from 24-hourly values). Actual measured total and methylmercury concentration data were used when available; for dates without mercury data, values were interpolated from the nearest two dates of sampling.

The methylmercury produced in and exported from Guadalupe and Almaden reservoirs is shown on Figures 4.10 and 4.11. Depending on the reservoir, there is three to 10 times as much methylmercury accumulated in the hypolimnion (lower cooler layer) than in the epilimnion (upper warmer layer). There is a substantial increase in methylmercury concentrations beginning in July, particularly for Guadalupe Reservoir. Methylmercury exports from Almaden Reservoir were similar to those from Guadalupe Reservoir (7.2 and 5 grams, respectively). More of the methylmercury produced in Almaden Reservoir was exported (7.2 grams) than retained (< 3 grams) prior to turnover; whereas approximately equal amounts were retained in and exported from Guadalupe Reservoir (about 5.5 grams). More methylmercury is exported during the dry season than during the wet season (Table 4.4).

The loads considered to this point are for one season. It is helpful to put these in the context of long-term loads, which is the subject of the next section.

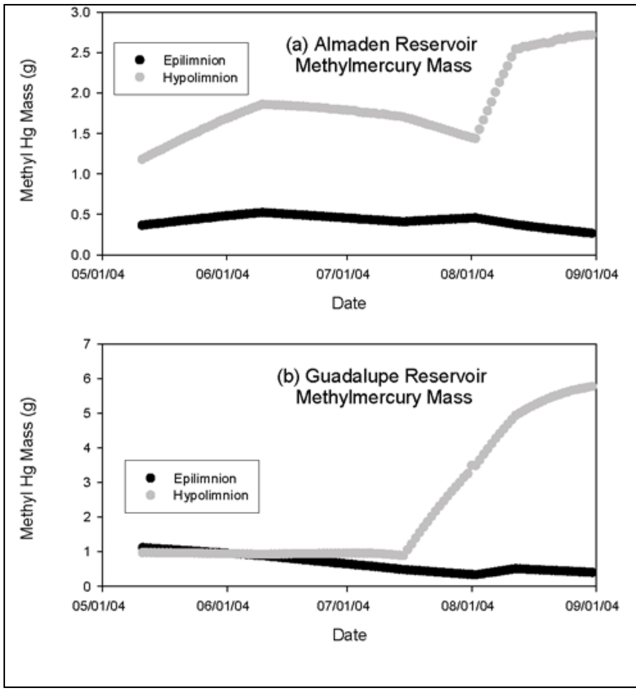



**Figure 4.10 Methylmercury Production Estimates in 2004 Dry Season**

*Citation: Figure 4-4 in Final Conceptual Model Report (Tetra Tech 2005c)*

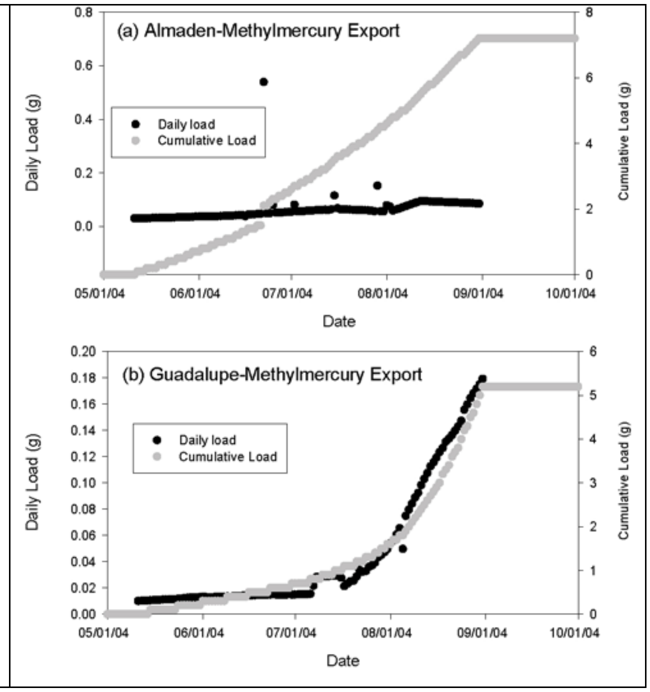



**Figure 4.11 Downstream Methylmercury Exports from Two Reservoirs**

*Citation: Figure 4-5 in Final Conceptual Model Report (Tetra Tech 2005c)*

**Table 4.4 Seasonal Reservoir Exports**

| Reservoir | Wet Season Total Mercury Exported (g) | Wet Season Methylmercury Exported (g) | Dry Season Total Mercury Exported (g) | Dry Season Methylmercury Exported (g) |
|---|---|---|---|---|
| Almaden | 110 | 0.8 | 21 | 7.2 |
| Calero | 28 | 0.3 | No data | No data |
| Guadalupe | 150 | 1.4 | 37 | 5.0 |
| Lexington | 140 | 0.9 | No data | No data |
| *Citations:* | *Figure 4.2* | *Figure 4.3* | *Table 4-6 in Final Conceptual Model Report (Tetra Tech 2005c)* | |

## *4.5 Long-Term Load Estimates*

The San Francisco Bay Mercury TMDL Implementation Plan for the Guadalupe River watershed (Looker & Johnson 2004) requires dischargers to demonstrate progress toward a) the interim loading milestone, or b) attainment of the allocation by using one of three methods listed below.

1) Quantify the annual average mercury load reduced by implementing a) pollution prevention activities, b) source and treatment controls, and c) if applicable, other efforts to reduce methylation or mercury-related risks to humans and wildlife. The

Water Board will recognize loads reduced resulting from activities implemented after 1996 (or earlier if actions taken are not reflected in the 2001 load estimate) to estimate load reductions.

2) Quantify the mercury load as a five-year annual average mercury load using data on flow and water column mercury concentrations.
3) Quantitatively demonstrate that the mercury concentration that best represents sediment discharged from the watershed to San Francisco Bay is below the suspended sediment target (0.2 mg/kg).

The load estimates discussed above are for the 2003-2004 wet season and 2004 dry season. The purpose of this section is to evaluate whether the five-year averaging period in Method 2, above, is appropriate for the Guadalupe River watershed.

The remainder of this section is largely taken from Section 4.12, "Recommended Averaging Time for Guadalupe River Loads to San Francisco Bay," of the *Final Conceptual Model Report* (Tetra Tech 2005c). Mercury loads exiting the Guadalupe River watershed vary substantially depending on the volume of flow. Given the historical variability of flows in the river, it is appropriate to define an averaging period and an associated baseline for loads against which any future loads must be considered. The averaging period must be chosen based on local site and climate characteristics. An averaging period that is too long will be insufficient to detect trends in changing loads, whereas an averaging period that is too short will be overwhelmed by year-to-year variability.

As a starting point, the Water Board has proposed a five-year averaging period. Figure 4-9 shows a comparison of the estimated loads as a function of the averaging period (three years, five years, seven years, and 11 years). The use of longer averaging periods has the benefit of smoothing out peaks caused by occasional very high flow years, which are typical of this watershed. However a long averaging period (e.g., 11 years)—if the averaging period includes even one year with an exceptionally high load—has the effect of elevating the average load for a long period of time. It is conceivable that watershed changes could occur over timeframes shorter than 11 years, particularly those associated with modification of the flow channel, as proposed in San Jose, or removal of sediments containing high levels of mercury from dams and river channels. For this reason, an 11-year averaging period is rejected as being too long, and a five- to seven-year averaging period is considered acceptable.

### 4.6 Other Potential Sources

Other potential sources of mercury include off-gassing from mining wastes and re-deposition, and water imports from the Central Valley. Note that industrial discharges are included in urban stormwater runoff loads, so they are not another potential source.

Mercury is volatile; mercury off-gassing from uncovered mining wastes and mercury-enriched surface soil is a local atmospheric source that may re-deposit in the Guadalupe River watershed. Natural off-gassing from mercury-enriched surface soil is included in the background source category (atmospheric deposition). The potential to reduce this source is limited. Previous and future vegetation or excavation and capping of mining wastes in the watershed are anticipated to reduce atmospheric inputs from local and regional sources, but no estimates are available.

Central Valley water transfers to Calero Reservoir are a potential, albeit small, source of mercury. However, there is no impairment of beneficial uses related to Central Valley water transfers to Calero Reservoir.

Industrial facilities are regulated by Waste Discharge Requirements (WDRs) and/or general industrial stormwater NPDES permits. Guadalupe Rubbish Disposal Company, Inc., owned by Waste Management, Inc., occupies the site of the former Guadalupe Mine and is the only industrial facility in the New Almaden Mining District. Landfill operations are subject to Waste Discharge Requirements Order No. 01-050 and General Industrial NPDES Stormwater Permit No. 97-03-DWQ. Discharges from landfill property which contain mining waste or practices which result in the discharge of mining waste from the landfill property are addressed by this TMDL.

***Key Points***

- There are four sources of mercury in the Guadalupe River watershed: mining waste, urban stormwater runoff, naturally occurring mercury in the soil, and atmospheric deposition; not every source contributes to every water body (see Table 4.1 and Figure 4.1).
- Loads of total mercury transported in the 2003-2004 wet season (see Figure 4.2 and Table 4.3) are useful to compare the relative magnitudes of different sources in the watershed; mining waste is by far the largest source.
- Large amounts of methylmercury were produced in Guadalupe and Almaden reservoirs in the 2004 dry season. Approximately equal masses of methylmercury were retained in Guadalupe Reservoir as were discharged to Guadalupe Creek, whereas more than twice as much methylmercury was discharged to Alamitos Creek as retained in Almaden Reservoir (Figures 4.10 & 4.11).
- Essentially, in the wet season, total mercury is transported in stormwater, whereas methylation and bioaccumulation largely occur in the dry season when and where the critical condition of low oxygen (anoxic conditions) occurs.

# 5. PROPOSED WATER QUALITY OBJECTIVES

Water quality objectives for mercury in waters of the San Francisco Bay region vary from watershed to watershed based on resident species, salinity, and beneficial uses.

The amendment we are proposing to the San Francisco Basin Plan is similar to that adopted in January 2007 for the Walker Creek watershed. The proposed amendment will add two new freshwater mercury water quality objectives and vacate an outdated objective for the Guadalupe River watershed. Mercury water quality objectives for all other water bodies in the San Francisco Bay Region will be updated either as part of a statewide action or as TMDLs are developed for mercury impaired waters.

The proposed objectives to protect aquatic organisms and wildlife apply to fish (5–15 cm in length and >15–35 cm in length) consumed by fish-eating birds in the watershed. The objectives are 0.05 mg methylmercury per kg fish (average wet weight concentration measured in whole trophic level 3 fish) for fish from 5 up to 15 cm in length and 0.1 mg methylmercury per kg fish (average wet weight concentration measured in whole trophic level 3 fish) for fish greater than 15 up to 35 cm in length.

The new objectives will replace the water column four-day average freshwater mercury objective, which will no longer apply to the Guadalupe River watershed. Replacement of the four-day average freshwater mercury objective with these fish tissue objectives reflects current scientific information and the latest U.S. EPA and U.S. Fish and Wildlife Service guidance.

### *Proposed Aquatic Organisms and Wildlife Objectives*

Numerous studies document methylmercury accumulation within the aquatic food web and its toxic effects on birds (Wiener et al. 2003). In the Bay Area, birds feeding on fish and other aquatic organisms are among the most sensitive wildlife methylmercury receptors (CDFG 2002; Davis et al. 2003). Bioaccumulation is largely dependent on the relative location of the species in the food chain, called the trophic level. Trophic level 1 plants are consumed by trophic level 2 herbivores, which are consumed by trophic level 3 predators, which are then consumed by trophic level 4 top predators. Because methylmercury bioaccumulates in the tissues of animals that ingest it, the highest methylmercury levels are found in the highest trophic level resident fish-eating (piscivorous) species. In this TMDL, staff proposes fish tissue methylmercury objectives that will protect the highest trophic level at-risk bird species in the Guadalupe River watershed.

The U.S. Fish and Wildlife Service (USFWS) developed the fish methylmercury thresholds discussed in this section with assistance from biologists at the Santa Clara Valley Water District regarding species present in the watershed. This section, "Proposed Aquatic Organisms and Wildlife Objectives," is largely based on *Derivation of Numeric Wildlife Targets for Methylmercury in the Development of a Total Maximum Daily Load for the Guadalupe River Watershed* (USFWS 2005). USFWS determined that a wildlife threshold that protects birds is also expected to protect other wildlife that rely on the Guadalupe River watershed for food.

Wildlife most likely at risk from methylmercury in the aquatic environment are terrestrial species that are primarily or exclusively piscivorous—they consume methylmercury that has bioaccumulated in their aquatic prey. Aquatic-dependent terrestrial species include reptiles, amphibians, mammals, and birds. State or federally listed threatened and endangered species in the Guadalupe River watershed include amphibians (e.g., red-legged frog), fish (e.g., Central California coast steelhead), and birds (e.g., California least tern and bald eagle). The fall-run chinook salmon is not listed; however it is regulated by NOAA Fisheries under the Magnuson-Stevens Fishery Conservation and Management Act.

Research into the effects of methylmercury on wildlife has generally focused on higher trophic level predators, such as piscivorous birds and mammals, rather than on reptiles and amphibians. The higher the trophic level, the greater the amount of methylmercury ingested from aquatic prey. Two piscivorous mammals, mink and river otter, are likely to be present in this watershed. Based on dietary analysis of piscivorous mammals and birds for the Cache Creek watershed, USFWS concluded that safe methylmercury thresholds for birds would be protective of these mammals. Therefore, thresholds protective of wildlife were developed for piscivorous birds (USFWS 2005). Prey fish species are listed in Table 5.1 by trophic level.

**Table 5.1 Fish Species Potentially Consumed by Piscivorous Birds**

| TL2 | TL3 | TL4 |
|---|---|---|
| None | Small bullheads, carp, small catfishes, black crappie, white crappie, goldfish, killifish, bigscale logperch, mosquitofish, California roach, golden shiner, inland silverside, Sacramento sucker, sunfishes (including pumpkinseed, bluegill, redear, and green), and steelhead/rainbow trout | Largemouth bass, large bullheads, large catfishes, anadromous steelhead |

Note: Trophic levels are approximate and simplified to primary trophic level.

Many piscivorous bird species frequent the watershed during the year. Because reproductive effects are the most sensitive indicators of methylmercury toxicity, the target species are those that forage in the watershed or are resident in or around the watershed during their breeding seasons. The five piscivorous species most vulnerable to methylmercury in the breeding season in the Guadalupe River watershed are common merganser (*Mergus merganser*), osprey (*Pandion haliaetus*), belted kingfisher (*Ceryle alcyon*), great blue heron (*Ardea herodias*), and Forster's tern (*Sterna forsteri*). Bald eagles visit only in winter and are not known to breed near or in the watershed. California least terns forage in South San Francisco Bay and are addressed in the San Francisco Bay Mercury TMDL.

The USFWS methodology for deriving wildlife thresholds recognizes that piscivorous birds obtain most of their methylmercury from fish in their diet, and that reproductive effects are the most sensitive indicators of adverse impacts from methylmercury. Previously published results of feeding studies on mallards were used to estimate the safe daily exposure to methylmercury. A margin of safety was applied to estimate a no-observable-adverse-effects concentration (NOAEC).

To better assess what types and sizes of fish birds in the watershed consume, USFWS reviewed published literature and determined that there are four main dietary preferences: TL3 fish less than 50 millimeters (mm) in length, 50-150 mm in length, and 150-350 mm in length; and TL4 fish 150- 350 mm in length. Note that the fourth size is smaller than the TL4 fish evaluated for human health (400 mm). The fish consumption rate, fish size, and fish trophic level were evaluated for each of these five bird species. Transfer of methylmercury between fish trophic levels was also considered. USFWS determined safe levels of prey fish methylmercury for wildlife in the Guadalupe River watershed as listed in Table 5.2.

**Table 5.2 Safe Prey Fish Methylmercury Levels**

| | TL3 Fish < 50 mm | TL3 Fish 50–150 mm | TL3 Fish 150–350 mm | TL4 Fish 150–350 mm |
|---|---|---|---|---|
| | (mg methylmercury per kg fish tissue, wet weight) | | | |
| Great Blue Heron | | 0.12 | | |
| Osprey | | | 0.10 | 0.20 |
| Common Merganser | | | 0.10 | |
| Forster's Tern | 0.05 | | | |
| Belted Kingfisher | | 0.05 | | |

USFWS determined that the threshold for belted kingfisher (0.05 mg methylmercury per kilogram of fish tissue [mg/kg] TL3 fish between 50–150 mm long) is sufficient to protect the great blue heron and should also be protective of the Forster's tern. Similarly, the threshold for common mergansers (0.1 mg/kg [rounded to one significant figure] TL3 fish between 150–350 mm long) is also protective of osprey. These TL3 size classes overlap at 150 mm, with the more protective methylmercury concentration being 0.05 mg/kg to protect the kingfisher.

Based on the USFWS work, and converting to centimeters (cm), **Water Board staff proposes water quality objectives of 0.05 mg methylmercury per kg fish tissue average wet weight concentration measured in whole TL3 fish between 5–15 cm long and 0.1 mg methylmercury per kg fish tissue average wet weight concentration measured in whole TL3 fish >15–35 cm long to protect wildlife.**

USFWS recommends that a fish tissue monitoring plan be developed to determine whether the assumptions it relied on to develop the thresholds are valid for the watershed (see Monitoring Program and Special Studies in Section 9). Furthermore, should its assumptions hold, it proposes that it would be reasonable to assign one threshold concentration (i.e., 0.1 mg/kg in >150–350 mm TL3 fish) that would be protective of all wildlife species in the watershed. Such a change in water quality objectives could be considered in the future through the adaptive implementation process described in Section 9.

### *Wildlife Water Quality Objectives and Human Health*

The new mercury water quality objectives proposed in Section 5.1 are intended to protect aquatic organisms and wildlife. These objectives have been calculated to protect piscivorous birds that, pound for pound, consume more fish than humans do. Therefore, we expect these wildlife objectives to be protective of human health. In this section we provide a quantitative analysis to demonstrate that this is the case.

When the wildlife water quality objective of 0.1 mg/kg average is achieved for >15–35 cm fish in the watershed, it is expected that the lower trophic level fish in the size class will have less methylmercury than the higher trophic level fish in the same class, and that the overall fish diet for piscivorous birds will average 0.1 mg/kg methylmercury. In our human health analysis, we assume that 1) the wildlife water quality objective of 0.1 mg/kg applies to TL3 fish only, and 2), a higher average methylmercury fish tissue concentration will be found in TL4 fish. This assumption is conservative in view of our goal of protecting human health.

A *trophic level ratio* (TLR) expresses changes in methylmercury bioaccumulation from one level in the food web to another, derived using fish of the same size classification (CVRWQCB 2004). Similarly, a *food chain multiplier* (FCM) expresses changes in methylmercury bioaccumulation from one level in the food web to the next, derived from our understanding of predator-prey relationships (*ibid.*). USFWS states that TLRs and FCMs are equally valid, and “if sufficient data on existing fish tissue methylmercury concentrations are available, food chain multipliers can also be established using the ratio of these concentrations between trophic levels” (USFWS 2005). USFWS goes on to advise that that the FCM approach should be used with following caveat:

> Calculating methylmercury targets for specific trophic levels requires that resultant limiting concentrations be applied to the appropriate food chain cohorts (e.g. a limiting concentration for TL3 must be applied to the species and size class of fish that would be consumed by larger predatory TL4 fish (USFWS 2005).

Based on extensive largemouth bass foraging studies in the Central Valley, the black crappie and largemouth bass fish data from 2003 in Guadalupe Reservoir are the appropriate size classes for a FCM (Keith 2006a, Keith 2006b, Moyle 2002), hence we have employed the FCM approach.

We used the summary data from Guadalupe Reservoir  to calculate a fish FCM from trophic level 3 to 4 (see Table A.9). The FCM, calculated by dividing the average largemouth bass (TL4) methylmercury concentration of 4.0 mg/kg by the average black crappie (TL3) methylmercury concentration of 2.0 mg/kg, yields a FCM of 2.0. This is equal to the 2.0 TLR calculated by the Central Valley Regional Water Quality Control Board for large TL4 fish (>15 cm length) and large TL3 fish (>15 cm length) in the Cache Creek watershed (CVRWQCB 2004); nearly equal to the 2.2 FCM calculated for Soulajule Reservoir (SFBRWQCB 2006); and is in the range of multipliers calculated for a national data set in 1994 by Bahnick et al., summarized in U.S. EPA’s *Water Quality Criterion for the Protection of Human Health: Methylmercury* (USEPA 2001).

The FCM can be used to calculate the trophic level 4 methylmercury concentration given a trophic level 3 methylmercury concentration by using Equation 5.1:

**Equation 5.1** [methylmercury in TL3] x FCM = [methylmercury in TL4]

When the wildlife water quality objective of 0.1 mg/kg is attained in trophic level 3, using the FCM of 2.0 in Equation 5.1, it will translate to 0.2 mg/kg in trophic level 4 fish (rounded to one significant figure). (As discussed in Section 5.1, USFWS has determined that fish tissue methylmercury concentration up to 0.2 mg/kg in TL4 fish 15–35 cm in length is protective of wildlife, specifically the osprey.)

Next, we calculate the trophic level 4 fish methylmercury concentration safe for human consumption, and compare it to 0.2 mg/kg. The following discussion regarding safe fish methylmercury concentrations for human consumption is excerpted from Section II.2, *Proposed Human Health Objective*, from the August 2006 San Francisco Bay mercury TMDL staff report (SFBRWQCB 2006).

The method used to evaluate safe fish methylmercury concentrations for human consumption is derived from the method the U.S. EPA used to develop its national criterion for methylmercury in fish tissue (USEPA 2001). To protect human health, U.S. EPA developed a criterion of 0.3 milligrams methylmercury per kilogram fish tissue (i.e., parts per million) using Equation 5.2:

**Equation 5.2:**

$$\text{Criterion} = \frac{\text{Body Weight x (Reference Dose - Relative Source Contribution)}}{\text{Fish Intake at Trophic Level}}$$

U.S. EPA assumed an adult body weight of 70 kilograms. The reference dose (RfD) in the equation is 0.0001 milligrams methylmercury per kilogram body weight per day (mg/kg-day). It represents a lifetime daily exposure level at which no adverse effects would be expected. It is derived from methylmercury levels shown to cause neurological developmental effects in children exposed to methylmercury prior to birth. In vitro exposure is the most sensitive exposure route and therefore the criterion is intended to protect for in vitro effects "In the studies so far published on subtle neuropsychological effects in children, there has been no definitive separation of prenatal and postnatal exposure that would permit dose-response modeling. That is, there are currently no data that would support the derivation of a child (vs. general population) RfD. This RfD is applicable to lifetime daily exposure for all populations including sensitive subgroups" (USEPA 2001). U.S. EPA's approach for developing its fish tissue criterion includes incorporating a factor of 10 in the RfD. The relative source contribution (0.000027 mg/kg-day) accounts for other sources of methylmercury exposure (USEPA 2001).

"Fish intake" is the consumption rate in kilograms/day. The relative location of the species in the food chain is called the trophic level (TL) (defined above). Below we first select an appropriate consumption rate, and then apportion it by trophic level.

In the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (USEPA 2000), U.S. EPA recommends a default fish intake rate of 17.5 grams/day (g/d) to adequately protect the general population of fish consumers, based on the 1994 – 1996 Continuing Survey of Food Intakes by Individuals (CSFII), conducted annually by the U.S. Department of Agriculture. The trophic level (TL) breakouts are TL2 = 3.8 grams/day (g/d); TL3 = 8.0 g/d; and TL4 = 5.7 g/d (USEPA 2000). The 17.5 g/d rate for the general adult population is protective of the majority of the population; it is the 90$^{th}$ percentile of the consumption rate for those who do and do not consume fish. In other words, 90 percent of the general population consumes less than 17.5 g/d. U.S. EPA considers the 17.5 g/d to be indicative of the average consumption among sport fishers (USEPA 2000).

Substituting the above values and the default fish intake rate (17.5 g/d) into Equation 5.2 yields the U.S. EPA methylmercury criterion of 0.3 mg/kg methylmercury in fish, rounded to one significant figure, as was done by U.S. EPA (USEPA 2001).

In their methodology document, U.S. EPA "suggests a four preference hierarchy for States and authorized Tribes to follow when deriving consumption rates that encourages use of the best local, State, or regional data available." The first preference is "(1) use of local data". Detailed local consumption data is available for San Francisco Bay, but not for the Guadalupe River itself, nor for the watershed as a whole. The very comprehensive consumption survey for San Francisco Bay was conducted in 1998 and 1999 and is documented in the report entitled, "Technical Report: San Francisco Bay Seafood Consumption Report" (CDHS & SFEI 2000).

To protect the Bay's beneficial use of sport fishing, methylmercury concentrations in Bay fish should be low enough so people who choose to eat Bay fish can do so on a regular basis. Consequently, staff selected the 95$^{th}$ percentile from the San Francisco Bay consumption study; 95% eat less than 32 g/d (one meal per week). Although fish species and seasonal abundance differ between the Bay, Guadalupe River, Lexington Reservoir and Vasona Lake, access for fishing these waters is similar and relatively easy. In contrast, access to fishing in the other upper watershed reservoirs (Guadalupe, Almaden and Calero) is more difficult (e.g. longer distance from freeways). Nonetheless, for seamless integration between the Bay and Guadalupe mercury TMDLs, let us evaluate the wildlife objective for the protection of human health based on a consumption rate of 32 g/d. Substituting this consumption rate into Equation 5.2 yields a safe methylmercury level, on average, of 0.2 mg/kg.

Next, we apportion the 32 g/d by trophic level. The national default is the only estimate for freshwater fish, so it is a better estimate to apply to the Guadalupe River watershed than the San Francisco Bay seafood consumption survey. The national default consumption rate for both freshwater and estuarine fish consists of 3.8 g/d TL2, 8.0 g/d TL3, and 5.7 g/d TL4 fish (USEPA 2001). However, there are no TL2 fish in the Guadalupe River watershed (see Table 5.1). Based on the national default consumption rates, the proportions are 60% TL3 and 40% TL4. For simplicity, let us consider a 50/50 ratio of TL3 to TL4. Therefore, below we estimate safe human health fish concentrations using a fish consumption rate at 16 g/d trophic level 3 and 16 g/d trophic level 4.

> The safe methylmercury level of 0.2 mg/kg is equal to the sum of the trophic level consumption rates multiplied by their respective fish methylmercury concentrations, as follows:
>
> 0.2 mg/kg = [50% x TL3] + [50% x TL4]
>
> Reorder Equation 5.1 and substitute:
>
> 0.2 mg/kg = [50% x (TL4/FCM)] + [50% x TL4]
>
> Where FCM = 2.0, trophic level 4 fish have a methylmercury concentration of 0.267 mg/kg. Rounding to one significant figure results in a trophic level 4 fish methylmercury concentration of 0.3 mg/kg.

Based on our knowledge of local fish species present in the watershed and using U.S. EPA's criterion and associated methodology, trophic level 4 fish with methylmercury concentrations of 0.3 mg/kg are protective of human health. Our proposed objective to protect wildlife translates to 0.2 mg/kg methylmercury for trophic level 4 fish. Therefore, this TMDL's wildlife water quality objective is protective of human health.

This analysis is provided to illustrate that the proposed wildlife fish tissue objectives are protective of human health. Since wildlife is the most sensitive receptor in the watershed, we are not proposing these objectives for the protection of human health. The proposed objectives are designated for the protection of aquatic life and wildlife. If the State proposes and adopts statewide human health fish tissue objectives for mercury, those objectives will apply in this watershed as well.

### *Vacate 4-day Average Marine Water Quality Objective*

The Basin Plan four-day average freshwater mercury water quality objective is based on science over two decades old (USEPA 1985). It is derived from the most sensitive adverse chronic effect, the U.S. Food and Drug Administration's (USFDA) action level to protect human health for mercury in commercial fish and shellfish (1.0 mg/kg) (USEPA 1985). The final residual value was calculated by dividing the lowest maximum permissible tissue concentration (USFDA action level of 1.0 mg mercury per kg fish) by the bioconcentration factor of 81,700 (the relative methylmercury concentration found in the fathead minnow compared to the total mercury concentration in the water fathead minnow lives in), which yields 0.012 µg/l, four-day average concentration not to be exceeded more than once every three years on average. In 1986, when promulgated in the Basin Plan, the U.S. EPA freshwater criterion for mercury of 0.012 µg/l was below the detection limit of 0.025 µg/l. (Using ultra clean sampling techniques and the latest analytical methods, the current detection limit is 0.0005 µg/l.) Therefore, the freshwater water quality objective for mercury was set at the 1986 detection limit of 0.025 µg/l. Every subsequent Basin Plan update has retained the 1986 Water Quality Objective. We propose that the proposed aquatic organism and wildlife objectives replace this four-day average water quality objective.

Although the Basin Plan 1-hour average marine and freshwater objectives are also based on this 1985 document, they are derived from toxicity tests on aquatic species themselves. Staff does not propose to vacate the 1-hour objective.

***Key Points***

- Water Board staff proposes fish methylmercury targets to protect aquatic organisms and wildlife. The two targets are equal to the water quality objectives, and are the following:

  0.05 mg/kg average wet weight concentration measured in whole TL3 fish between 5–15 cm long, and

  0.1 mg/kg average wet weight concentration measured in whole TL3 fish >15–35 cm long.

- The wildlife objectives also provide protection of humans who consume up to one meal per week of watershed fish.
- Water Board staff proposes to vacate the 4-day average water quality objective.

# 6. Numeric Targets

"Numeric targets" are measurable conditions that demonstrate attainment of water quality standards. Targets are the maximum amount of mercury (solid, suspended, liquid, or airborne) allowed in a certain amount of water, fish tissue, or sediments. A numeric target can be a 1) numeric water quality objective, 2) numeric interpretation of a narrative objective, or 3) numeric measure of some other parameter necessary to meet water quality standards. Targets must be measurable, and they must be designed to demonstrate attainment of water quality standards. The proposed targets are equal to the proposed water quality objectives.

To protect human health and wildlife in the Guadalupe River Watershed, Water Board staff proposes two methylmercury fish targets. The proposed targets are intended to protect beneficial uses of waters impaired by mercury. The targets are based on available information and are intended to be at least as protective as established water quality objectives. Other targets could also be equally protective of beneficial uses and could be considered in the future through the adaptive implementation process described in Section 9 (Implementation and Monitoring).

In addition to numeric targets, Water Board staff proposes age-1 fish tissue methylmercury concentrations as remediation effectiveness indicators. A description of age-1 fish and corresponding methylmercury data are provided in the *Data Collection* and *Final Conceptual Model Reports* (Tetra Tech 2005a & 2005c), and the remediation effectiveness indicators are described in Section 9.9 (Fish Tissue Mercury Monitoring).

### *Numeric Targets*

The numeric targets are the fish-tissue water quality objectives for the protection of aquatic organisms and wildlife, which are also protective of humans who consume as much as one meal per week of watershed fish (see Section 5). The targets are the following:

- 0.05 mg methylmercury per kg fish, average wet weight concentration measured in whole trophic level 3 fish 5–15 cm in length, and
- 0.1 mg methylmercury per kg fish, average wet weight concentration measured in whole trophic level 3 fish >15–35 cm in length.

### *Anti-Degradation*

The numeric targets proposed in this TMDL must be consistent with antidegradation policies. Title 40 of the Code of Federal Regulations (§131.12) contains the federal antidegradation policy. State Water Resources Control Board Resolution 68-16 contains California's antidegradation policy. These antidegradation policies are intended to protect beneficial uses and the water quality necessary to sustain them. When water quality is sufficient to sustain beneficial uses, it cannot be lowered unless doing so is consistent with the maximum benefit to the citizens of California. Even then, water quality must sustain existing beneficial uses.

To be consistent with the antidegradation policies, the numeric targets proposed in this TMDL, taken together, cannot be less stringent than existing water quality objectives. As described in "Water Quality Standards Attainment" (see Section 7.7), the proposed numeric targets together are as protective as the Basin Plan narrative water quality objective for bioaccumulation. Because fish methylmercury concentrations already exceed the bioaccumulation objective, meeting the numeric targets would improve current water quality conditions and resolve the bioaccumulation impairment. Therefore, the proposed targets are consistent with the antidegradation policies and the protection of water quality and beneficial uses.

***Key Points***

- "Numeric targets" are measurable conditions that demonstrate attainment of water quality standards.
- Water Board staff proposes two fish-tissue targets equal to the proposed water quality objectives, as follows:

  0.05 mg methylmercury per kg fish average wet weight concentration measured in whole trophic level 3 fish 5–15 cm in length, and

  0.1 mg methylmercury per kg fish average wet weight concentration measured in whole trophic level 3 fish 15–35 cm in length.

- These targets also protect humans who consume as much as one meal per week of watershed fish.

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# 7. LINKAGE ANALYSIS

The main purpose of the linkage analysis is to describe the links between sources and targets (fish tissue methylmercury concentrations) and to determine appropriate TMDLs and allocations (Section 8). These links include the transport of mercury from sources to water bodies, the chemical transformations that occur in water, and the bioaccumulation of mercury. The linkage analysis is presented in the following sections:



This analysis describes the four sources of mercury in this watershed: mining waste, urban runoff, atmospheric deposition, and naturally occurring mercury in soil. But the linkage between these sources and the numeric targets (fish tissue methylmercury concentrations) is not direct. As illustrated in the diagram below (Figure 7.1), the sources and the numeric targets are linked by the sites where methylmercury is produced.

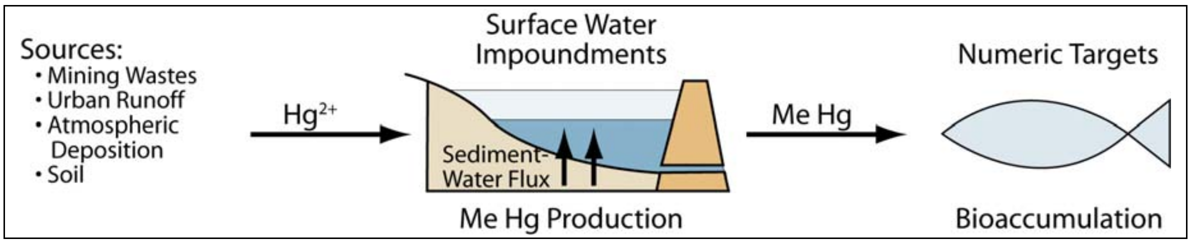



**Figure 7.1 Linkage Between Sources, Methylmercury, and Targets**

*Citation: Prepared by Tetra Tech under contract to Water Board*

Dissolved mercury ($Hg^{2+}$) enters surface waters, is converted to methylmercury (MeHg) primarily in reservoirs and lakes (surface impoundments), and then bioaccumulated up the food chain into fish.

Impoundments are engineered structures, such as dams, drop structures, and former quarries, which cause water to pond. In the Guadalupe River watershed, the largest impoundments on the creeks and river—Guadalupe, Almaden, and Calero reservoirs and Lake Almaden—have been identified as the primary sites of methylmercury production and bioaccumulation. Data supporting the linkage from mercury sources to fish tissue targets is described in the next section.

## *7.1 Qualitative Linkage from Sources to Targets*

The largest source of mercury in the Guadalupe system is mining waste (see Table 4.3). A strong indication of the linkage between sources and targets in the watershed is the high fish tissue mercury concentrations in close proximity to the New Almaden Mining District, and the lower fish tissue concentrations both farther downstream from the mining district and in Los Gatos Creek outside the mining district, as illustrated on Figure 7.2.

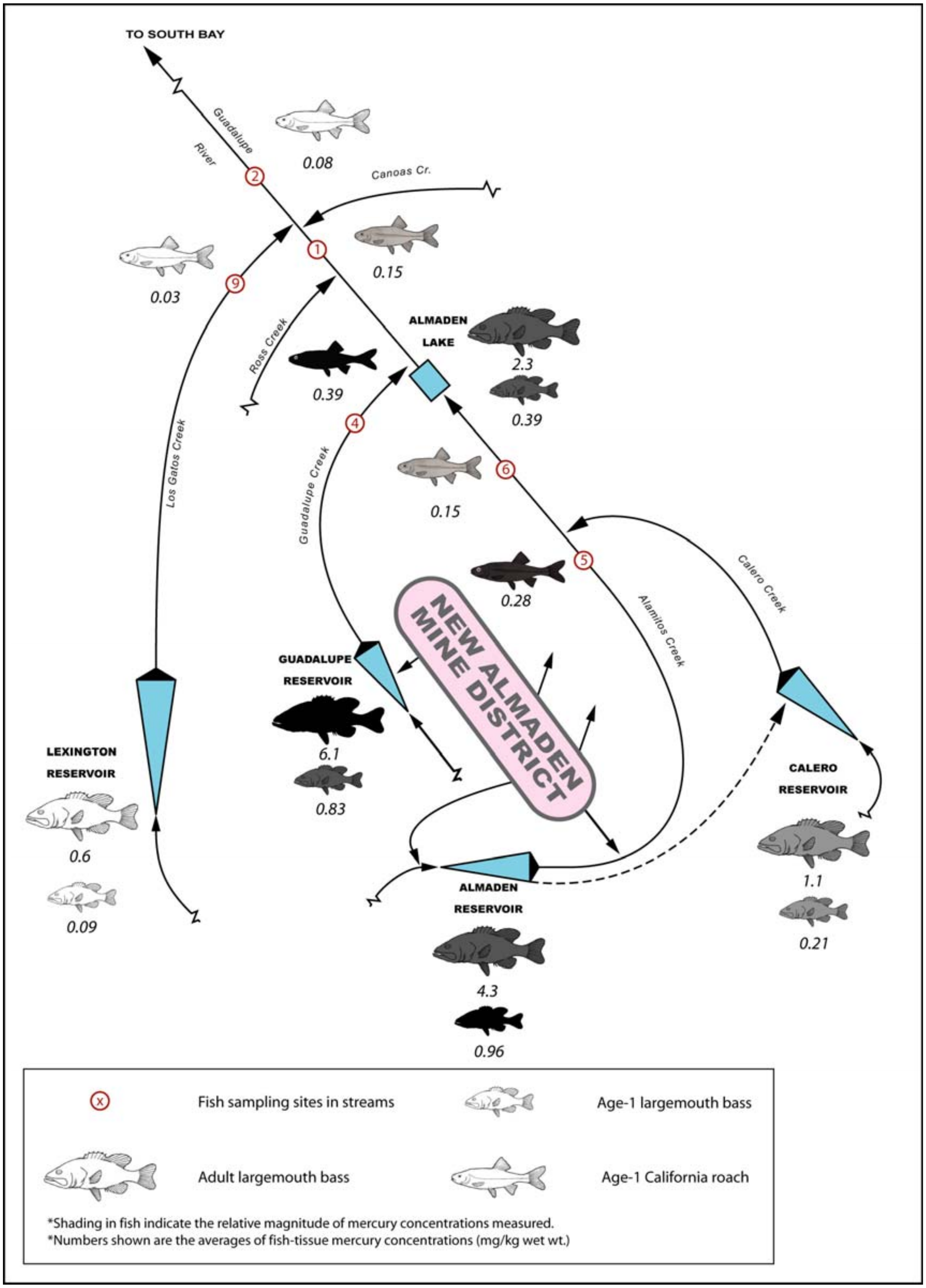



**Figure 7.2 Summary of 2004 Fish Data**

*Citation: Figure 3-25 Final Conceptual Model Report (Tetra Tech 2005c)*

Fish with highest mercury concentrations are darkest, and found in close proximity to mercury mines.

Mines discharge mercury-laden sediment, some of which accumulates in impoundment bottom sediments. Figure 7.3 illustrates 2005 sediment and 2004 fish data from three reservoirs (Tetra Tech 2005b and 2005a, respectively, and Appendix B). Lexington Reservoir sediment samples ranged from 85–100% fines (silts and clays of less than 63 microns; see Section 7.6). There is a clear trend toward higher mercury concentrations in fish tissue with higher reservoir sediment mercury concentrations. The median reservoir bottom sediment total mercury concentrations range from 0.1 milligrams of mercury per kilogram of sediment (mg/kg, parts per million) in Lexington to 3.0 mg/kg in Guadalupe Reservoir. Corresponding fish tissue mercury concentrations in standardized 40 cm largemouth bass range from 0.6 mg/kg in Lexington to 5.8 mg/kg in Guadalupe Reservoir.

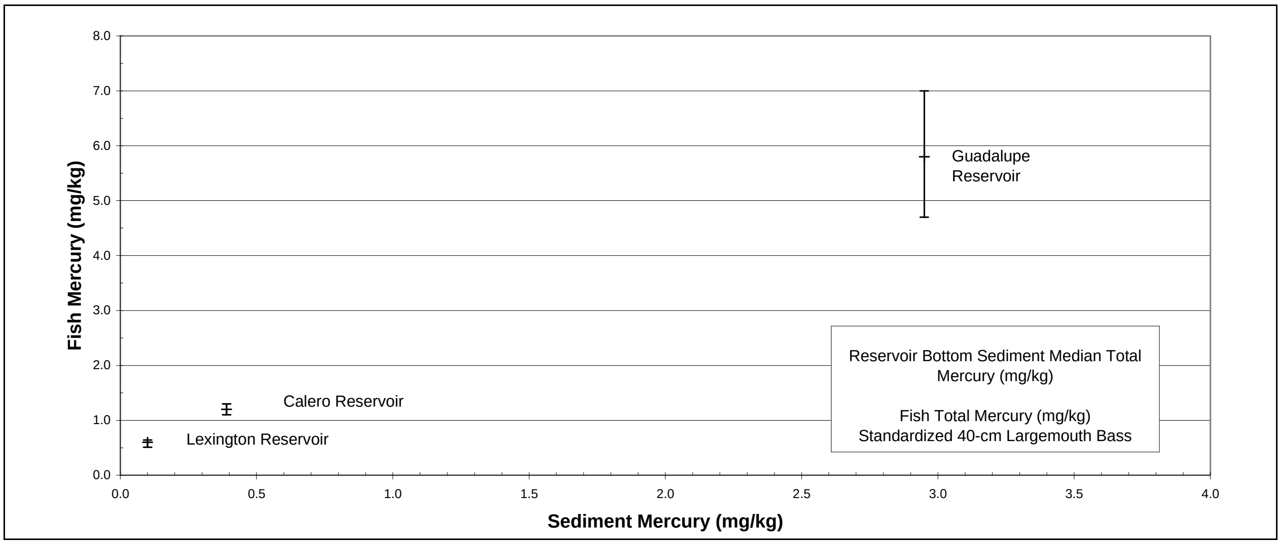



**Figure 7.3 Fish and Reservoir Sediment Mercury Results**

Reservoir bottom sediment and fish tissue mercury concentrations increase from the reference reservoir (Lexington), to Calero (receives mining waste via a canal), to Guadalupe Reservoir (located immediately downstream of mercury mines).

#### CONCEPTUAL MODEL REPORT

The data collection efforts and *Final Conceptual Model Report* that inform the scientific basis of this TMDL are described in Section 3 (Conceptual Model). Sections 7.2 through 7.5 herein are taken largely from the *Final Conceptual Model Report* which, particularly in Section 5.0, provides a detailed explanation of the linkage between sources and targets (namely mercury transport, transformation, and biological uptake and bioaccumulation in fish, Tetra Tech 2005c). The *Conceptual Model Report* references studies described in the literature which show that in order for mercury to bioaccumulate in fish tissue, it must first be converted into the organic methylmercury form. The conditions in reservoirs in the watershed that lead to methylmercury production and bioaccumulation are described in the next section.

## 7.2 Conditions in Guadalupe Watershed Reservoirs

Mercury's transformations from one chemical form to another (including methylation), and within water, air, or sediments, involve complicated interactions among biological, physical, and chemical factors that defy simplification. For the purposes of this TMDL, however, the following paragraphs cover some relevant basics of these interactions.

For mercury to be methylated, it must first be available in its dissolved form to sulfate-reducing bacteria, which occur naturally in the environment. Mercury dissolves into this form through solubilization from inorganic particles. In the water column, where sulfate reduction takes place, mercury in the dissolved phase exists primarily as aqueous complexes associated with sulfides, natural organic matter, and other ligands.

The forms of mercury most likely to be taken up by bacteria and methylated are uncharged mercury-sulfide complexes (mercury$S^0$ and mercury $(SH)_2^0$), according to recent experimental and field studies. Other aqueous complexes of mercury also have the potential to be taken up by bacterial cells. Limited data indicate that there is a range of sulfate concentrations over which methylation is stimulated, and concentrations greater than or less than this range tend to suppress methylation. Sulfate-reducing bacteria convert sulfate to sulfides for energy, and in the process methylate mercury, converting it from dissolved inorganic to dissolved organic mercury (i.e., methylmercury). Relative to the primary activity of bacterial conversion of sulfate to sulfides, methylation is generally hypothesized to be an incidental activity. The increased concentrations of sulfides resulting from natural bacterial activity accelerate weathering of mercury solids which, coupled with methylation, appears to be a significant means of bringing methylmercury into solution in these waters. Methylation can occur in the sediment or anywhere in the water column where sulfate reduction occurs. Demethlyation can also occur in the environment, as a result of different physical and biological processes.

Because a large quantity of mining waste was present in the creek canyons prior to construction of Almaden and Guadalupe reservoirs, the bottom sediments in these reservoirs are a significant source of mercury. In addition, particulate and dissolved mercury loads continue to be transported to Almaden and Guadalupe reservoirs during each wet season (and to Calero Reservoir via the Almaden-Calero Canal). Following thermal stratification early in the dry season, low dissolved oxygen levels in the lower layer (hypolimnion) promote the activity of sulfate-reducing bacteria and therefore sulfide production. Sulfide production enhances the solubility of particulate mercury both in the sediments and suspended in the water column. The sulfate-reducing bacteria take up the solubilized mercury and form methylmercury (Figure 7.4). Methylmercury enters algal cells at the base of the food chain (Figure 7.5).

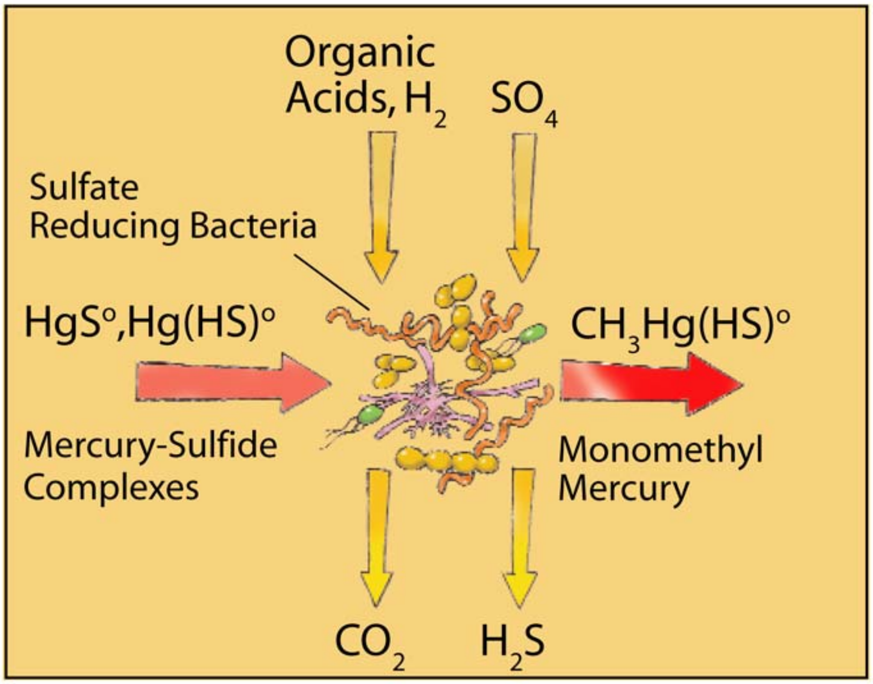



**Figure 7.4 Mercury Methylation by Sulfate-Reducing Bacteria**

*Citation: Figure 5-5 Final Conceptual Model Report (Tetra Tech 2005b)*

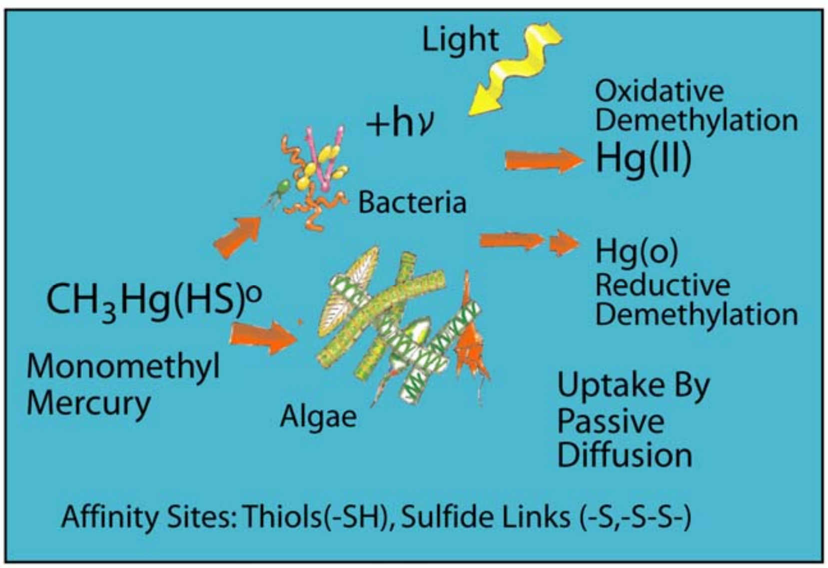
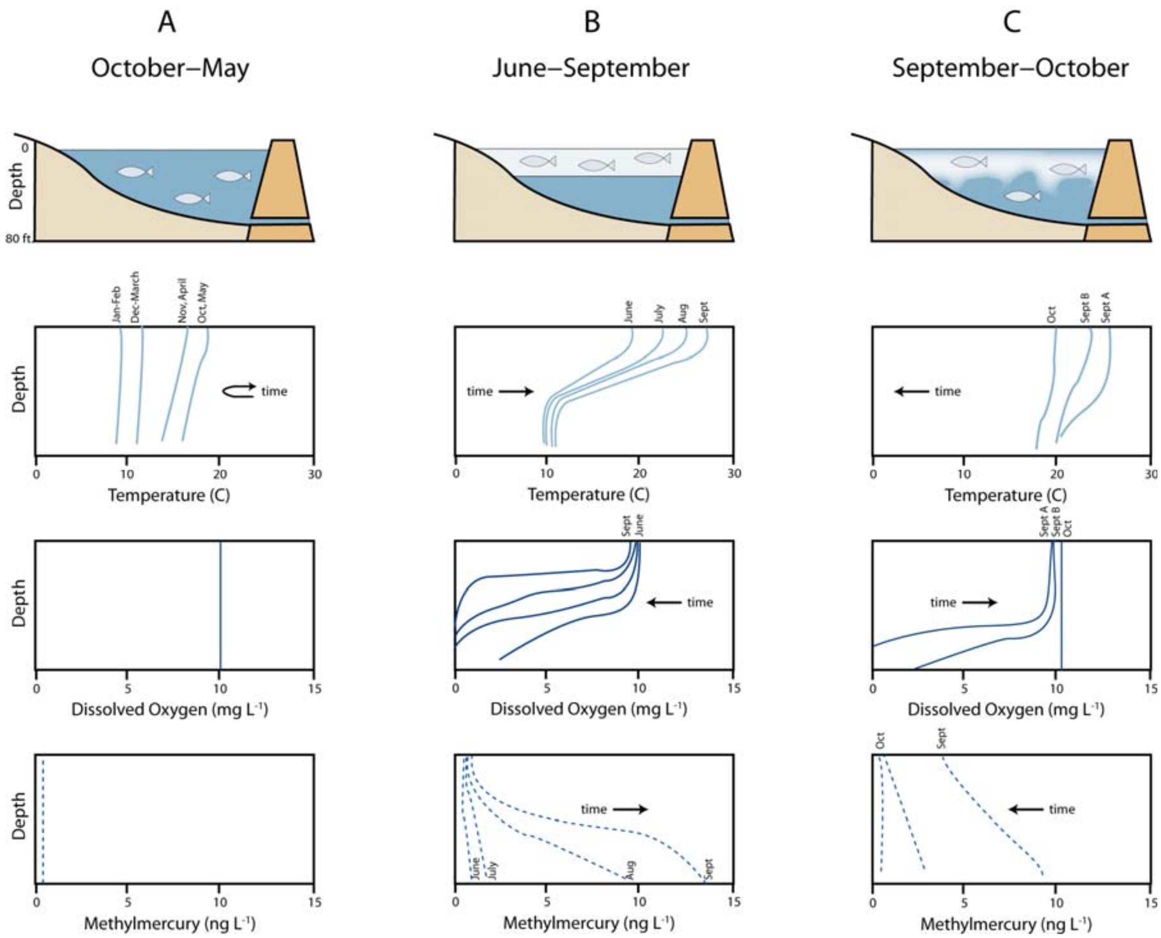



**Figure 7.5 Methylmercury Uptake and Loss Processes**

*Citation: Figure 5-6* Final Conceptual Model Report *(Tetra Tech 2005b)*

The annual hydrologic cycle in the reservoirs and the observed behavior of methylmercury cycling in the Guadalupe and Almaden reservoirs are summarized on Figure 7.6.




## Figure 7.6 Annual Hydrologic Cycle in Reservoirs

*Citation: Figure 5-13 Final Conceptual Model Report (Tetra Tech 2005b)*

Methylmercury is produced and accumulates in the hypolimnion of reservoirs and lakes in the dry season (Panel B).

### *PANEL A (FIGURE 7.6): OCTOBER – MAY*

During most of the year, the reservoirs are well mixed, and fish and other aquatic organisms are found throughout the water column. The temperature decreases as the wet season and winter period commence, and increases again in the spring, but the temperature and the dissolved oxygen concentrations (at near-saturation levels; oxygen gas dissolves from air into water, and the equilibrium concentration is called "saturation") remain relatively unchanged with depth. From October through May, methylmercury concentrations are at low levels (less than 1.0 nanogram of methylmercury per liter of water [ng/l, part per trillion]) for this watershed and are also constant with depth.

### *PANEL B (FIGURE 7.6): JUNE – SEPTEMBER*

Like most deep water bodies, Almaden and Guadalupe reservoirs become thermally stratified between late spring and early fall (June - September, although the exact timing varies from year to year). The stratification period is characterized by an upper layer (epilimnion) of uniformly warm (20$^{o}$ - 26$^{o}$C), well-mixed water. The water in the lower layer (hypolimnion) is cold ($10^o$ - $14^oC$). Dissolved oxygen becomes depleted by the bacterial decomposition of organic matter in the water column, as well as at the sediment-water interface where bacterial decomposition is at its maximum. As shown in Figure 7.6, both the thermal stratification and dissolved oxygen depletion increase over the dry season. During thermal stratification, fish are restricted to the epilimnion.

A number of studies have shown noteworthy increases in methylmercury concentrations in the hypolimnion during the stratification period (Herrin et al. 1998; Sellers et al. 2001; Watras & Bloom 1992). In Guadalupe and Almaden reservoirs, the increase in the concentration of methylmercury in the hypolimnion is pronounced. From concentrations of less than 1 part per trillion in the well-mixed period (October - May), the concentrations of methylmercury in the hypolimnion near the bottom increase to greater than 10 ng/l during the stratification period.

#### *PANEL C (FIGURE 7.6): SEPTEMBER - OCTOBER*

In the early fall, declining air temperatures result in a loss of heat from surface waters, and solar radiation cannot make up for the heat loss. The surface waters cool and sink as they become denser than the underlying epilimnion. The continual cooling of the surface waters leads to progressive deepening of the epilimnion and increased circulation throughout the water column. The increased circulation leads to a breakdown of stratification and the restoration of oxygen concentrations (at near saturated levels) throughout the water column.

Several investigators have shown that the introduction of methylmercury produced in the hypolimnion during stratification and its uptake by phytoplankton represents an important internal source of methylmercury in lakes or reservoirs, and also a significant entry point of mercury into the food web (Herrin et al. 1998; Gorski et al. 1999; Sellers et al. 2001; Slotton et al. 1995). Methylmercury produced in the hypolimnion during stratification is quickly taken up by phytoplankton during the mixing at the end of the stratification period (Herrin et al. 1998). The uptake of methylmercury in zooplankton and fish increased dramatically during the fall mixing of California's Davis Creek Reservoir, which is contaminated by mercury mining activities (Slotton et al. 1995). These studies also show that biotic uptake of mercury is both rapid and short-lived. The decrease in water-column methylmercury is equally rapid (within a period of days to weeks). In addition to biological uptake, methylmercury can be lost from, or degraded in, the water column as it adsorbs to particles, settles in sediments, or degrades in sunlight.

## *7.3 Mercury Transport and Linkage*

The largest source of mercury in the Guadalupe system is mining waste, which is located in three general areas:

- Waste materials in the New Almaden Mining District; particularly poorly managed waste that is easily eroded and transported in stormwater runoff,
- Wastes previously transported into Guadalupe and Almaden reservoirs and their tributary creeks, and
- Wastes previously transported into the river system below Guadalupe and Almaden reservoirs.

Because of the higher rates of methylation in impoundments, and the efficiency with which biota take up methylmercury, wastes that have been transported to impoundments are of particular significance with respect to mercury bioaccumulation.

In the Guadalupe River watershed, much of the rainfall, and most of the streamflow volume, occur during the wet months (October through May). Mercury transport is closely tied to water flows, and the most significant transport occurs in the wet months. Mercury is transported predominantly in the inorganic particulate form, with two important exceptions: a) dissolved mercury mobilized by small storms and b) methylmercury produced in impoundments during the dry season.

In the upper part of the watershed that drains the New Almaden Mining District, dissolved mercury loads during small storms in the wet season can be significant, and represent a quarter or more of the total mercury load. The proportion of dissolved mercury is much less in large storm events that transport most of the load (see note 4 on Table 4.3). This corresponds to wet season findings from the Gambonini Mercury Mine in the Coast Range where particulate mercury represented over 99.97% of the total mercury transported (Whyte & Kirchner 2000). Nonetheless, the load of dissolved mercury imported from the upper watershed to each of the Guadalupe and Almaden reservoirs (60 grams each, Figure 4.4) is about 10 times the amount of methylmercury exported from each of these reservoirs (Figure 4.11). In other words, the dissolved mercury load entering the reservoirs from the mining district during the wet season is sufficient to account for all the methylmercury produced within the reservoir, and later exported from the reservoir.

Methylmercury production and export are much greater in the two reservoirs adjacent to the mining district than in other impoundments in the watershed. Given the greater degree of contamination in these two reservoirs, Guadalupe and Almaden, Tetra Tech evaluated their contribution to the watershed's total load separately

The 2004 dry season study of Guadalupe and Almaden reservoirs documented a substantial increase in methylmercury beginning in July, particularly for Guadalupe Reservoir. More of the methylmercury produced in Almaden Reservoir was exported (7.2 grams) than retained (< 3 grams) prior to turnover; whereas approximately equal amounts were retained in and exported from Guadalupe Reservoir (about 5.5 grams). More methylmercury is exported during the dry season than during the wet season (Table 4.4). This is a key finding of the dry season monitoring—reservoirs are net producers and exporters of methylmercury to downstream waters.

Monitoring results also indicate that late in the dry season, a significant fraction (more than 30 percent) of the total mercury in the hypolimnion of Guadalupe and Almaden reservoirs was comprised of methylmercury. In many instances, total methylmercury concentrations were higher than the dissolved mercury concentrations, indicative of a very high methylation efficiency in the system during the dry season. This observation may be linked to the fact that conditions that enhance dissolution of solid-phase mercury (elevated sulfide concentrations) also enhance the production of methylmercury, as explained in more detail below.

In the dry season, both total and dissolved methylmercury concentrations in the creeks flowing from the reservoirs decrease with distance downstream from the reservoirs (see

July 2003 data on Figure 7.7). This decrease in dissolved methylmercury also holds true for Guadalupe River, where it decreased from 1.72 ng/l in Lake Almaden to 0.113 ng/l in the Guadalupe River downstream of the Alamitos Drop Structure (Tetra Tech 2003).

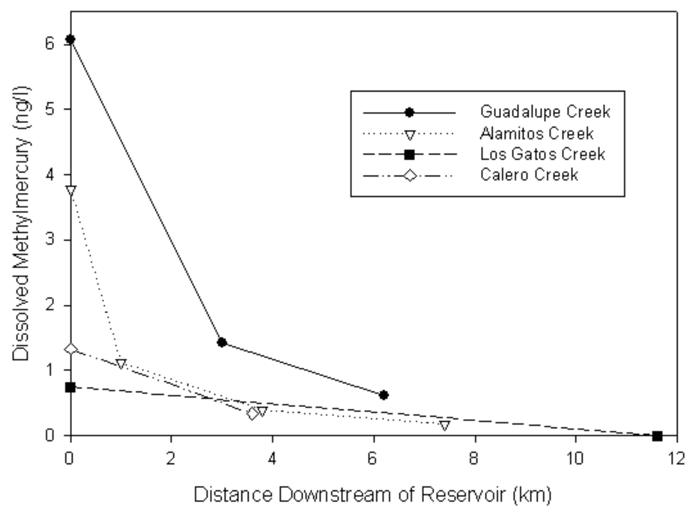



**Figure 7.7 Dissolved Methylmercury Below Reservoirs, July 2003**

*Citation: Figure 5-10 Final Conceptual Model Report (Tetra Tech 2005c)*

Methylmercury concentrations decrease with distance downstream of reservoirs.

Fish samples from two locations in both Alamitos Creek and the Guadalupe River had higher mercury concentrations in the upstream samples than in the downstream samples. The samples were collected at Sites 5 and 6 on Alamitos Creek (see Figure 7.3) (average concentrations of 0.28 and 0.26 mg/kg, respectively), and in the Guadalupe River at Sites 1 and 2 (average concentrations of 0.15 and 0.08 mg/kg, respectively). Although there may be sites for methylation in the stream and river channels, it appears that their total contribution to methylmercury production and bioaccumulation is much smaller than the reservoir exports during the dry season.

To sum up mercury transport on a watershed scale, at most locations in the wet season, the quantity of methylmercury and dissolved total mercury being transported is a small fraction of the total mercury. In the dry season when methylmercury production peaks, however, a significant fraction of the total mercury in outflows from the more contaminated impoundments is methylmercury (more than 30 percent). The amount of methylmercury decreases with distance downstream from these reservoirs. Methylation is much greater in these impoundments than in stream and river channels. But in general, methylation can occur wherever sulfate-reducing bacteria are active, although the deeper waters in impoundments and the upper few centimeters of sediment appear to be the most important zones.

The main points in linkage and transport are that the wet season is largely a time of transport of inorganic particulate mercury from the four sources in this watershed: mining waste, urban runoff, atmospheric deposition, and naturally occurring mercury in soil. In contrast, the dry season is characterized by mercury methylation by naturally occurring bacteria. Methylation principally occurs in the oxygen-depleted depths of impoundments, which are engineered structures. Methylmercury is the most bioavailable form of mercury. Bioaccumulation is the subject of the next section.

### *7.4 Quantitative Linkage from Methylmercury in Water to Targets*

Methylmercury bioconcentrates as it moves up the food chain from algae to zooplankton to prey fish and to predator fish (Figure 7.8). The largest single jump in concentration occurs from the water to algae. The biomagnification of methylmercury is among the largest biomagnifications of all known chemical compounds. Concentrations in fish muscle tissue can be millions of times higher than in water. Unlike the qualitative linkage above, the link from methylmercury in water to fish tissue targets can be quantified as a bioaccumulation factor.

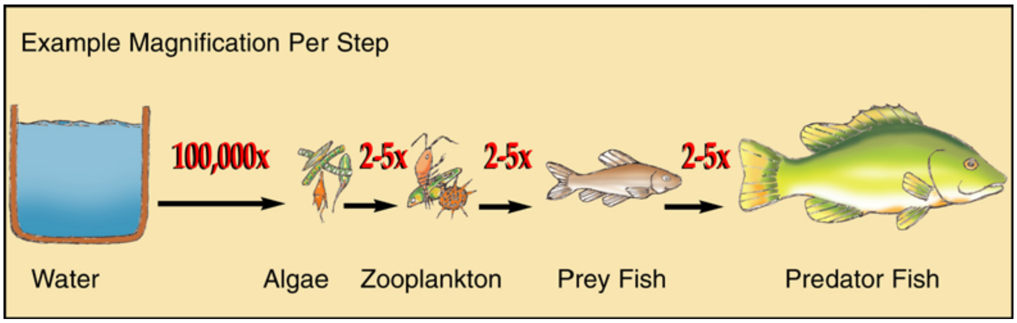



**Figure 7.8 Food Chain Biomagnification of Methylmercury**

*Citation: Figure 5-7 Final Conceptual Model Report (Tetra Tech 2005c)*

Methylmercury concentrations increase dramatically from the water column into algae, and continue to increase up the food chain.

A summary of the 2004 fish sampling results is shown in the Figure 7.3 schematic diagram of the Guadalupe River watershed. The figure depicts the range of measured concentrations of mercury in the fish tissue for each sampling location. The shading of the fish symbols indicates the relative magnitude of the measured concentrations. The highest concentrations of mercury in adult largemouth bass muscle tissue were measured at Guadalupe Reservoir in the New Almaden Mining District, where the range of values was 3.1–13.0 mg/kg wet weight (wt.) muscle tissue for adults, and 0.64–1.1 mg/kg wet wt. whole-body (eviscerated) samples for age-1 fish. The lowest mercury concentrations in both the adult and age-1 largemouth bass were measured at Lexington Reservoir outside of the New Almaden Mining District, where the ranges of mercury values were 0.4–1.0 mg/kg wet wt. muscle tissue for adults, and 0.06–0.14 mg/kg wet wt. whole-body samples for age-1 fish.

The stream sampling sites, where the California roach tissue samples were collected, are also shown on the watershed diagram. The highest concentrations in the whole-body (eviscerated) California roach samples were measured at Guadalupe Creek in the New Almaden Mining District (Site 4), where the range of mercury concentrations was 0.31–0.48 mg/kg wet wt. The lowest concentrations in the California roach were measured at Los Gatos Creek outside of the New Almaden Mining District (Site 9), where the range of values was 0.02–0.04 mg/kg wet wt.

The differences in the fish tissue mercury concentrations exhibited in Figure 7.3 were examined further to establish a quantitative linkage between water column methylmercury concentrations and fish tissue mercury concentrations (numeric targets).

The bioaccumulation factor (BAF) is the ratio of the fish tissue mercury concentration to the water column mercury concentration in units of liters of water per kilogram of fish:

Equation 7.1

$$\text{Bioaccumulation Factor (BAF)} = CT/CW * 10^{-6}$$

CT = Methylmercury concentration in the fish tissue, mg/kg
CW= Methylmercury concentration in the water, ng/l

Available data for the calculation of the bioaccumulation factors (BAFs) at different trophic levels in the aquatic ecosystem include measurements of mercury concentrations in the water, plankton, and fish in July 2003 and in 2004. The following paragraphs present the BAFs for a) phytoplankton (two impoundments), b) zooplankton (five impoundments), c) adult largemouth bass and age-1 largemouth bass (five impoundments), and d) California roach at four stream and two river locations.

Phytoplankton BAFs were calculated based on measurements of total and dissolved methylmercury in shallow water samples, and total methylmercury in phytoplankton from two impoundments, collected in September 2004 by USGS staff (Kuwabara et al. 2005, Kuwabara 2006). Methylmercury was not detected in phytoplankton in the other three impoundments sampled. Total and dissolved methylmercury concentrations in Almaden Reservoir were $1.25 \pm 0.25$ and $0.32 \pm 0.07$ ng/l, respectively (n=2). Total methylmercury was detected in the single phytoplankton sample at 4 ng/g dry wt. The BAF for phytoplankton (using total methylmercury in water) is approximately 3,200.

Zooplankton BAFs were calculated in a similar manner: measurements of total and dissolved methylmercury concentrations in shallow water samples and total methylmercury in zooplankton from five impoundments, also collected in September 2004 by USGS staff (Kuwabara et al. 2005). The BAF calculated with the epilimnion average total methylmercury concentration (0.36 ng/l) and zooplankton average methylmercury concentration (0.90 nanograms of methylmercury per gram of zooplankton, ng/g, parts per billion, dry wt.) at Guadalupe Reservoir is greater than 2 million (Tetra Tech 2005d; SFBRWQCB 2005e). The zooplankton BAFs in this study are consistent with mercury trophic-transfer factors in literature published on other lakes and show the importance of the uptake of methylmercury by the lower trophic levels.

To support development of fish BAFs and other TMDL calculations, measurements of total mercury in fish throughout the watershed were collected in 2004 (see Section 3.1). USEPA collected adult and age-1 largemouth bass from four reservoirs (Guadalupe Reservoir, Almaden Reservoir, Calero Reservoir, and Lexington Reservoir), and Lake Almaden. The Santa Clara Valley Water District collected age-1 California roach (*Lavinia symmetricus*) at six creek and river locations.

BAFs for adult largemouth bass were developed from average total mercury concentrations in fish and unfiltered (total) and filtered (dissolved) methylmercury concentrations in the surface and hypolimnion of the five impoundments. (See Appendix B, Calculation B.1.) In Table 7.1 we present the BAFs for both total and dissolved methylmercury, and both average and peak concentrations, at the discharge point (referred to as hypolimnion, since water is released from reservoirs at a depth below the thermocline). (In Appendix B, Calculation B.1, we include BAFs for the full data set.)

The BAFs for adult fish compared to average hypolimnion total and dissolved methylmercury range from 400,000 to 1.8 million. The BAFs for adult fish compared to peak hypolimnion total and dissolved methylmercury range from 240,000 to 1.1 million (see Table 7.1).

Water column mercury concentrations in Almaden, Guadalupe, and Lexington reservoirs are well characterized. Average concentrations for Almaden and Guadalupe reservoirs are from measurements taken on one day in July 2003 and six days between May 11 and August 31, 2004. Average concentrations for Lexington Reservoir are from measurements on one day in July 2003 and semi-monthly samples in 2004. Peak concentrations for Guadalupe, Almaden, and Lexington reservoirs are estimated from measurements taken between mid-May and early September 2004. A single value is used for the surface-water methylmercury concentration at Lake Almaden and Calero Reservoir. These samples were collected in 2003 during the synoptic survey (Tetra Tech 2003). There is no measurement for the hypolimnion at Lake Almaden.

### Table 7.1 Adult Largemouth Bass Bioaccumulation Factors (l/kg)

| Location | Hypolimnion (discharge point) Average 2003-2004 | | Hypolimnion (discharge point) 2004 Estimated Peak | |
|---|---|---|---|---|
| | **Total Methylmercury** | **Dissolved Methylmercury** | **Total Methylmercury** | **Dissolved Methylmercury** |
| **Guadalupe Reservoir** | 1,100,000 | 1,700,000 | 500,000 | 800,000 |
| **Almaden Reservoir** | 990,000 | 1,800,000 | 580,000 | 1,100,000 |
| **Lake Almaden** | - - | - - | - - | - - |
| **Calero Reservoir** | 400,000 | 830,000 | - - | - - |
| **Lexington Reservoir** | 1,100,000 | - - | 240,000 | - - |

Note:
- - = not measured

Similarly, age-1 largemouth bass BAFs were calculated from measurements of total mercury in the fish and the same set of impoundment methylmercury data used for the adult BAFs. The BAFs for age-1 fish compared to average hypolimnion total and dissolved methylmercury range from 76,000 to 390,000. The BAFs for age-1 fish compared to peak hypolimnion total and dissolved methylmercury range from 35,000 to 240,000 (see Table 7.2).

**Table 7.2 Age-1 Largemouth Bass Bioaccumulation Factors (l/kg)**

| Location | Average Methylmercury 2003-2004 Total Methylmercury | Average Methylmercury 2003-2004 Dissolved Methylmercury | 2004 Estimated Peak Methylmercury Total Methylmercury | 2004 Estimated Peak Methylmercury Dissolved Methylmercury |
|---|---|---|---|---|
| **Guadalupe Reservoir** | 150,000 | 230,000 | 70,000 | 110,000 |
| **Almaden Reservoir** | 220,000 | 390,000 | 130,000 | 240,000 |
| **Lake Almaden** | - - | - - | - - | - - |
| **Calero Reservoir** | 76,000 | 160,000 | - - | - - |
| **Lexington Reservoir** | 170,000 | - - | 35,000 | - - |

Note:
- - = not measured

Because the zooplankton methylmercury concentrations are reported on a dry-weight basis, this number is not directly comparable to the BAF values for the fish samples from these same waters. Nonetheless, we offer the following observations for impoundments (Kuwabara 2006). Using surface water total methylmercury concentrations, the BAFs for phytoplankton, zooplankton, age-1 fish and adult fish are approximately 3,200, 690,000, 1,200,000, and 7,600,000, respectively. The corresponding food chain multipliers (FCMs, see Section 5.1) are approximately 200, 3, and 6. The FCM between phytoplankton and zooplankton (200), is an order of magnitude lower than the initial accumulation by phytoplankton (3,900), but two orders of magnitude greater than subsequent accumulation steps by fish (3 and 6).

One would not expect particle-bound methylmercury to be as bioavailable as dissolved methylmercury. Using dissolved rather than total methylmercury concentrations in the example from Almaden Reservoir, the BAFs for phytoplankton and zooplankton would be approximately 12,000 and 2.7 million, respectively. In this case, the FCM between phytoplankton and zooplankton is 220 (similar to the estimate based on total methylmercury concentrations), again much smaller than the initial uptake step by phytoplankton (12,000). Results reported by Kuwabara et al. (2005) provide only an initial, temporally constrained look at mercury trophic transfer in the watershed. This data does demonstrate, however, the high uptake of methylmercury at the lowest trophic levels. Now let us examine BAFs for creeks and the river.

California roach BAFs were developed from mercury concentrations measured in fish sampled at six creek and river locations in 2004 (from the data collection effort – see Section 3.1), and in surface samples from five nearby sites in 2003 (from the synoptic survey – see Section 3.1). The calculated BAF values are consistent with observations in other systems where methylmercury is taken up rapidly in the water column by algae and transferred by ingestion to zooplankton and planktivorous fish (Tetra Tech 2005d). The concentration of methylmercury in the California roach is approximately 300,000 to 600,000 times higher than the methylmercury levels in the water column. The results of the fish sampling and measurements of mercury in tissue samples provide valuable new information to support the use of fish tissue as a numeric target for the TMDL.

### 7.5 Implications for TMDL

The research and analysis described in the preceding linkage sections suggest that a) both dissolved and total mercury loads must be reduced, and b) reducing methylmercury production to attain targets in reservoirs in the mining district may also attain targets in downstream waters.

There are three hypotheses (*H*) about the source(s) of methylmercury in the impoundments, and the relative contribution of each source to methylmercury loads and bioaccumulation. Current data from the watershed are inadequate to evaluate the validity of these hypotheses.

$H_1$: particulate mercury in bottom sediments in the dry season is solubilized due to high sulfide concentrations; dissolved mercury diffuses out of the sediment into the hypolimnion where it is methylated.

$H_2$: particulate mercury in bottom sediments in the dry season is solubilized due to high sulfide concentrations, methylated in the sediment, and methylmercury diffuses from the sediment to the hypolimnion.

$H_3$: dissolved mercury transported to the impoundments in the wet season is methylated in the hypolimnion in the dry season.

Based on current data from the Almaden and Guadalupe reservoirs, the relative contributions of the sediments or the water column are yet to be discerned. However, given that substantially more mercury exists in the sediment, it is reasonable to assume that the sediments are the larger source. (For a given volume, sediments at 1 mg/kg of mercury may contain three orders of magnitude more mercury than water at 100 ng/l.)

The implications for the TMDL are that both dissolved and total mercury loads must be reduced. In Section 9 (Implementation Plan), actions are proposed to prevent mining waste and reduce urban runoff from entering water bodies and/or continuing to be transported downstream. These actions will reduce both particulate mercury concentrations in impoundment sediments and loads of dissolved mercury to impoundments.

Although there may be sites for methylation in the stream and river channels, as discussed in “mercury transport and linkage” above, their total contribution to methylmercury production is much smaller than the exports from the reservoirs and Lake Almaden during the dry season. This suggests that that reducing methylmercury production to attain TMDL targets in reservoirs in the mining district and Lake Almaden will likely also attain targets in downstream waters.

## *7.6 Mercury in the Reference Reservoir*

Previous linkage sections explained mercury transport, transformation to methylmercury, and bioaccumulation. Now we examine how these concepts apply under background conditions (no mining waste or urban runoff) and whether numeric targets are achieved. This provides options to consider as allocations in the next section.

#### *MERCURY SOURCES TO THE REFERENCE RESERVOIR*

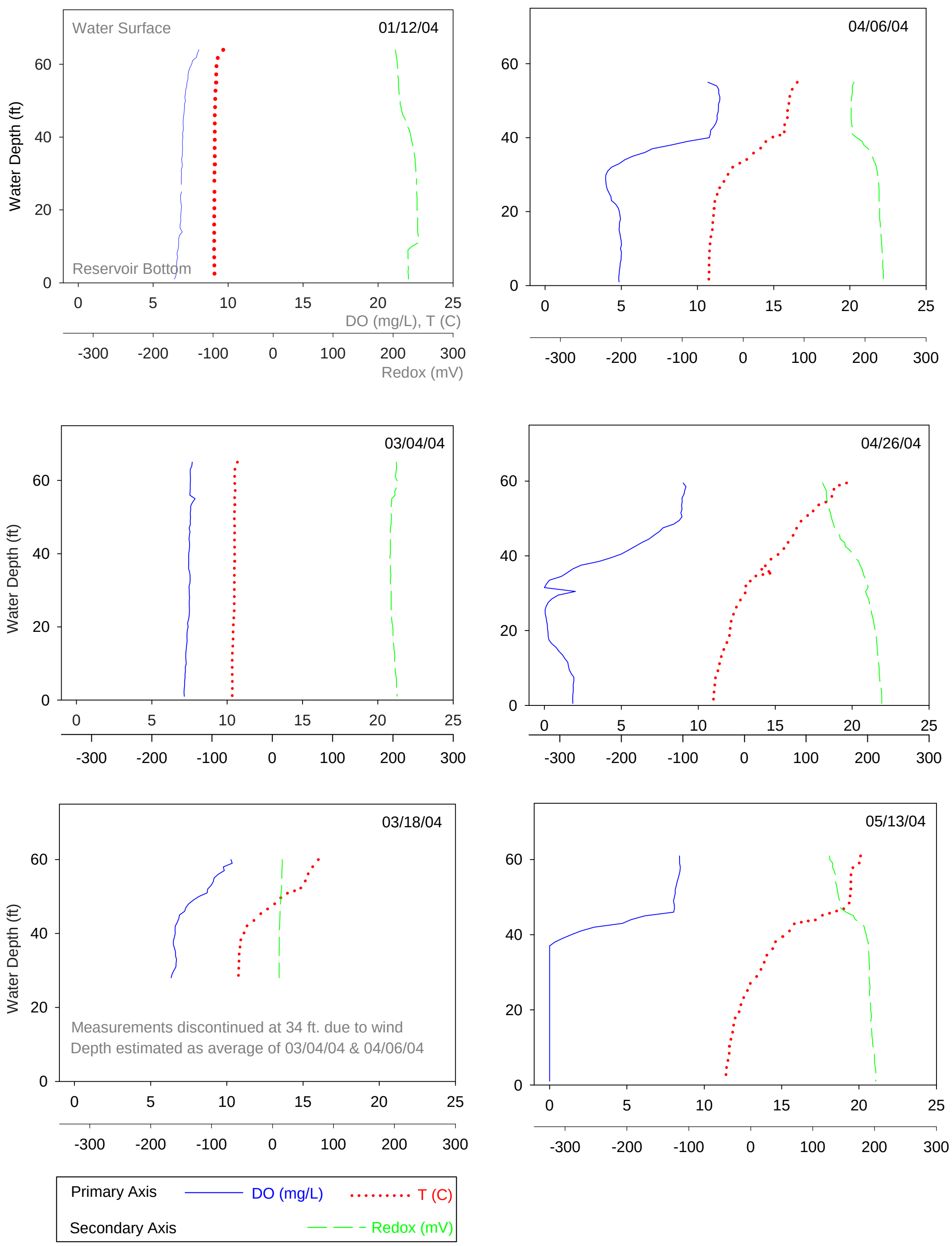
The upper portion of the Los Gatos Creek subwatershed (from the headwaters to Lenihan Dam, i.e., Lexington Reservoir) is considered background because it receives no mercury mining waste or urban runoff. Two sources contribute mercury to the background area: naturally occurring mercury in soil and atmospheric deposition (an anthropogenic source). Consequently, the readily accessible reservoir (Lexington) was selected as the reference reservoir for this TMDL.

#### *METHYLATING CONDITIONS IN THE REFERENCE RESERVOIR*

As described in Section 7.2, in the warm dry season under low oxygen conditions, inorganic mercury is converted to methylmercury by naturally occurring sulfate-reducing bacteria. To evaluate methylating conditions in the reference reservoir, depth profiles were collected once a month throughout 2004, and twice a month in the dry season, in Lexington Reservoir.

Depth profiles from the water surface to the bottom of the reference reservoir (at 1-foot intervals) were collected at about 500 feet offshore of roughly the dam centerline. Profile parameters include: dissolved oxygen (DO), temperature (T), oxidation-reduction potential (REDOX), conductivity, turbidity, salinity, and total dissolved solids. Depth profiles are plotted on Figure 7.9a-c of T (to evaluate thermal stratification), DO (to evaluate anoxic conditions favorable for methylation), and REDOX (to evaluate conditions favorable for sulfate reduction) (LAS 2004). (See also Figure 7.6.) (Additionally, plots of pH depth profiles for selected dates are provided in Appendix A, Figure A.3c.)

The shape of the depth profiles for temperature, dissolved oxygen, and oxidation-reduction potential correspond to seasonal thermal stratification. Beginning with the May 13 profile, the temperature profile shows a shift to lower temperatures at about a 15-foot depth (Figure 7.9a.) At this same depth and as a result of thermal stratification, oxygen levels decrease in the hypolimnion. As the season progresses, these anoxic conditions are expected to be conducive to sulfate reduction. Indeed, at the next measurement on May 25, the oxidation-reduction potential depth profile shows a distinct shift at the thermocline to reduction conditions—favorable to sulfate reducing bacteria and mercury methylation (Figure 7.9b.)




## Figure 7.9a Lexington 2004 Depth Profiles

The straight profile lines in January and February indicate well-mixed conditions; the distinct shift in the profile in May indicates stratified conditions.

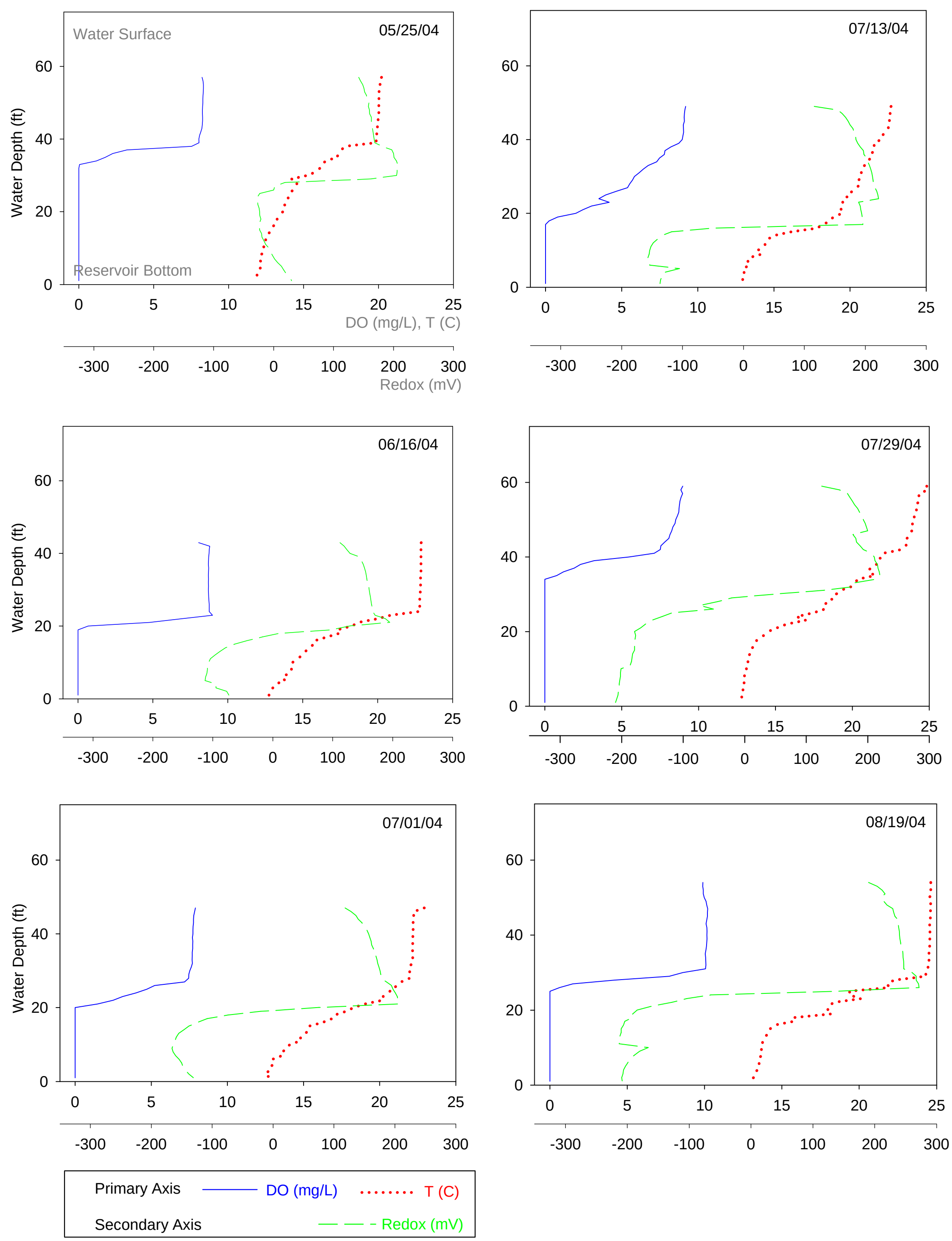
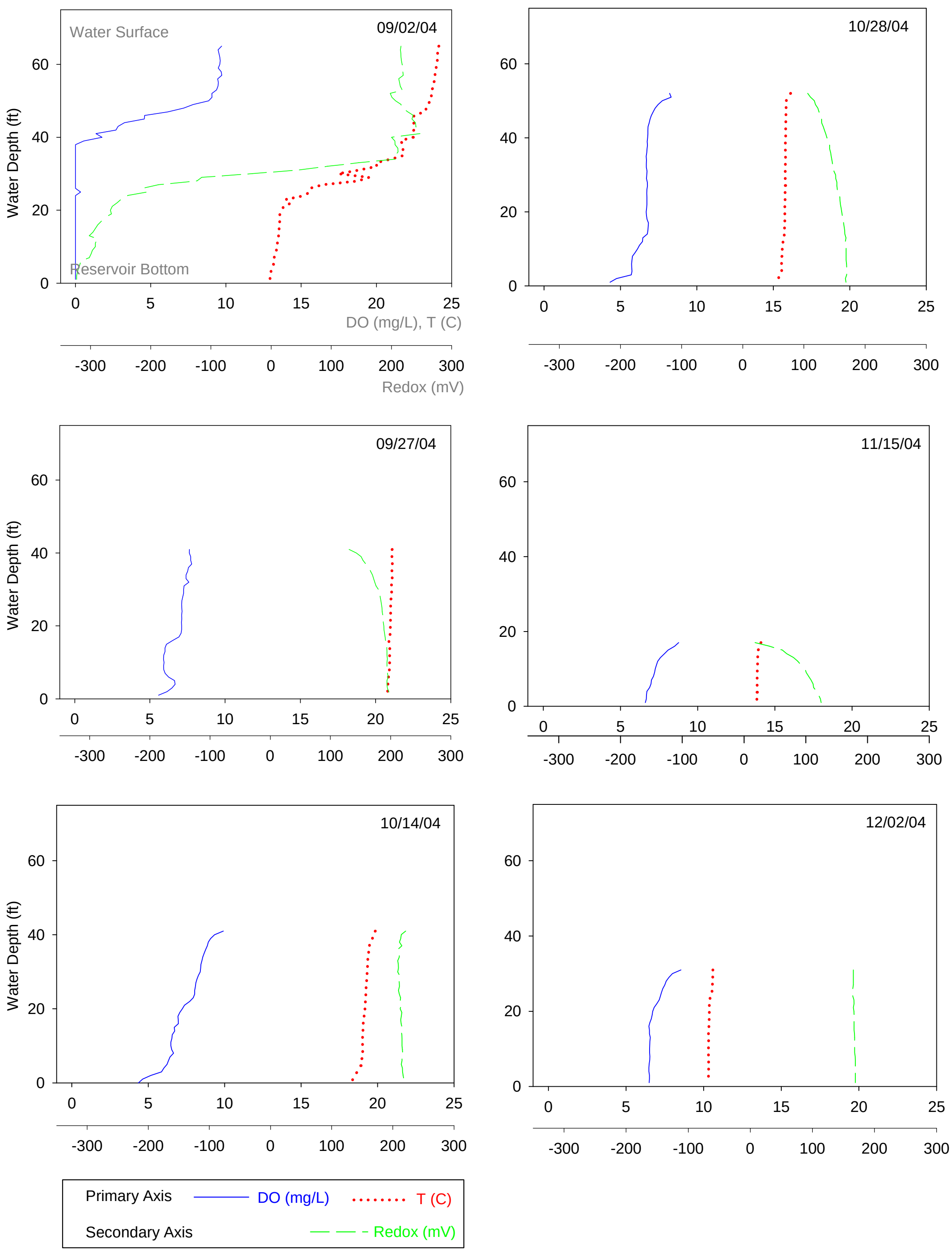



**Figure 7.9b Lexington 2004 Depth Profiles**

The reservoir remained stratified through August.




## Figure 7.9c Lexington 2004 Depth Profiles

The reservoir experienced turnover in September, and remained well-mixed through December.

***METHYLMERCURY IN THE REFERENCE RESERVOIR***

Methylmercury is a particular focus of this TMDL because it is the most bioavailable form of mercury. Methylmercury concentrations increase notably in the deep portions (hypolimnion) of thermally stratified impoundments, until the seasons change (see Figure 7.6 Panel B.) As explained in the discussion of Figure 7.6 Panel C, the greatest uptake of methylmercury in impoundments occurs as the deep and shallow waters mix ("turnover") each fall. In addition to the depth profiles described previously, reference reservoir hypolimnion methylmercury concentrations were collected. The samples were collected at the outlet to Lexington Reservoir once a month throughout 2004, and twice a month in the dry season, and are plotted on Figure 7.10 (LAS 2004; Table A.3b).

We estimate that the 2004 seasonal maximum methylmercury concentration in the hypolimnion of the reference reservoir was 2.6 nanograms of methylmercury per liter of water (ng/l, parts per trillion) and occurred on September 18. Measured hypolimnion methylmercury peaked at 2.43 ng/l in a replicate sample on September 2, 2004. Based on the temperature depth profiles in Figures 7.10 below, turnover occurred between September 2 and 27, 2004.

The shorter day length in autumn, hence less solar radiation, is the prime contribution to turnover (Goldman & Horne 1983, p.52.) Weather also plays a role in the timing of turnover, and data from the Los Gatos weather station indicates the daily temperature fell on September 18, 2004, and slight precipitation occurred the next day (NOAA 2007). Based on our linkage analysis, it is reasonable to assume that methylmercury concentrations continued to rise from September 2 until September 18. A linear regression of methylmercury concentrations from May to September 2, then extrapolated to September 18, 2004, yields an estimated peak hypolimnion methylmercury concentration of 2.6 ng/l (Figure 7.10). In Section 8.2, we evaluate peak hypolimnion methylmercury concentrations as a potential allocation for this TMDL.

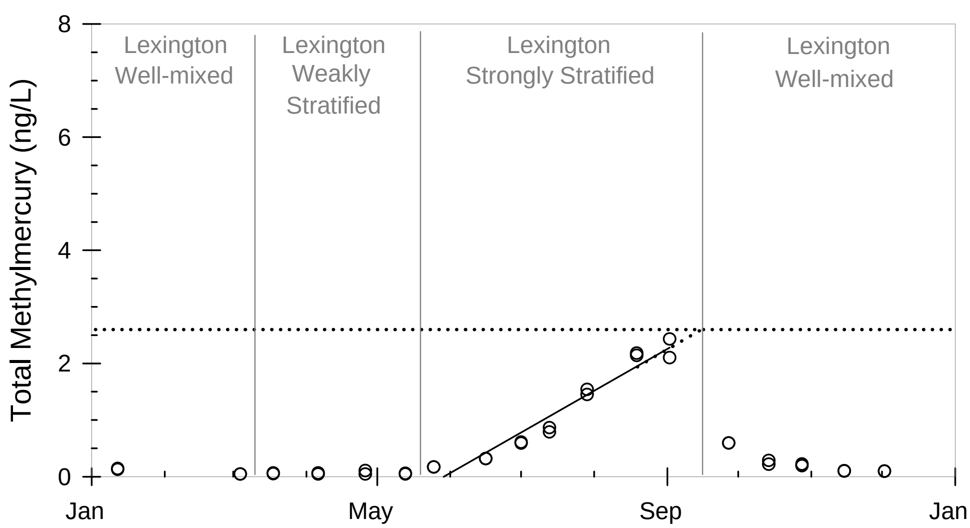



**Figure 7.10 Reference Reservoir 2004 Hypolimnion Methylmercury**

The 2004 estimated seasonal maximum methylmercury concentration in the hypolimnion of the reference reservoir was 2.6 ng/l on September 18.

#### *FISH MERCURY CONCENTRATIONS*

Fish tissue mercury concentrations are the best measure of bioaccumulation and consequently were selected as the numeric targets for this TMDL. Largemouth bass were collected from the reference reservoir in 2004 before turnover. To provide a more comprehensive data set, other fish species were collected in 2006. In 2006, the fish were collected after turnover. The fish data are provided in Appendix A, Tables A.7a, A.8a, and A.8b.

##### Small Prey Fish Mercury Concentrations and Turnover

Recall from Section 7.2 that the greatest bioaccumulation occurs during turnover in the fall. In California's Davis Creek Reservoir, located in the Coast Range about 70 miles north of San Francisco, juvenile largemouth bass mercury concentrations increased, on average, 2–3 fold from spring to fall. The fish mercury concentrations increased somewhat during the summer growth period while the reservoir was strongly stratified, but increased greatly after August (Slotton et al. 1995).

The 2004 small prey fish samples are representative of average annual fish mercury concentrations. The 2004 fish samples were collected on September 1, 2004, when the reservoir was still strongly stratified (Figure 7.9c), and before turnover, which occurred on or after September 18, 2004. As discussed above, the largest pulse of bioaccumulation occurs at turnover.

In contrast, the 2006 small prey fish samples were collected after turnover, so they are representative of peak annual fish mercury concentrations. The 2006 samples were collected on November 5, 2006, when the reservoirs were mixed. Next, we compare the 2004 and 2006 small prey fish data to numeric targets, keeping in mind the sample and turnover dates.

##### 2004 Small Prey Fish and Wildlife

The wildlife target was just met in 2004. This conclusion was based on the fish data analysis described in the next paragraph.

The age-1 largemouth bass provide an estimate of wildlife prey mercury concentrations. The 50–150 mm TL3 fish tissue target to protect wildlife is 0.05 mg/kg on average (Section 6). Even at age-1, largemouth bass are considered TL4. The increase of mercury from one trophic level (TL, see Section 5) to the next is described by the "trophic level ratio" (TLR). The TLR from TL3 to TL4 is approximately 2 (USFWS 2005). Average mercury in age-1 largemouth bass, of average length 89 mm, was 0.09 mg/kg. Dividing the mercury concentration (0.09 mg/kg) by the TLR (2) yields the equivalent mercury concentration in TL3 of 0.05 +/- 0.01 mg/kg (+/- standard deviation), just equal to the target.

To more accurately assess the risk to wildlife, in 2006 we collected TL3 fish species consumed by wildlife. Before we discuss the 2006 fish data, let us examine the fluctuations in water level in the reference reservoir.

##### Reference Reservoir Water Levels and 2006 Fish Data

A construction project was underway in the reference reservoir (Lexington) during the 2006 dry season. Some concerns arose about whether the reservoir was drawn down to depths that would adversely affect the fishery. The water level in the reference reservoir, and other reservoirs in the watershed, is illustrated on Figure 7.11, below. The water levels rise during the wet season, and fall during the dry season. In the last three years (2003, 2004, and 2005), the lowest water levels were reached in mid-December. We conclude that the 2006 drawdown in the reference reservoir was typical of many years, and not the most extreme over the previous decade (which occurred in late 1999).

The reference reservoir fish sample dates are also illustrated on Figure 7.11. In 2006 the fish were collected after several months of steady decline in the water level. In contrast, in 2004, the fish were collected during relatively stable water levels, just before the reservoir was drawn down prior to the wet season. We conclude from this graph that fish sampled in both 2004 and 2006 are representative of typical fishery conditions.

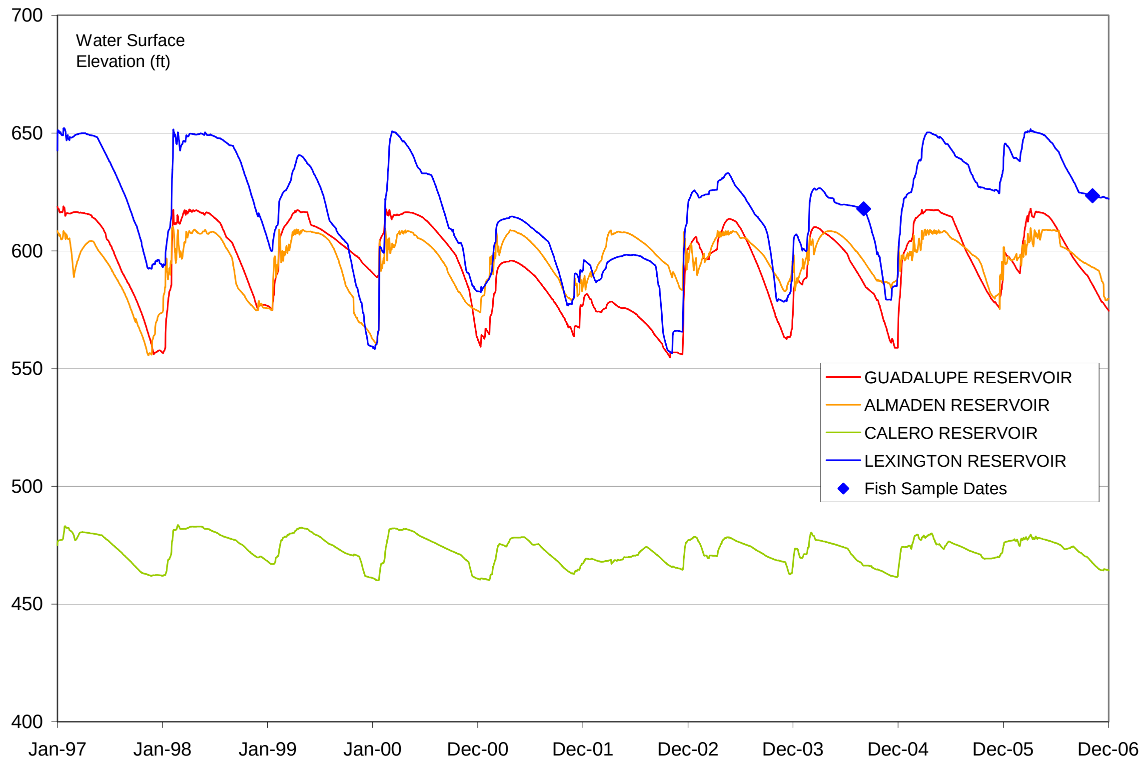



**Figure 7.11 Reservoir Water Levels 1997–2006**

The 2006 drawdown in the reference reservoir was typical for the decade.

#### 2006 Small Prey Fish and Wildlife

The wildlife target was exceeded in 2006. The fish caught in November 2006 match the wildlife target species and length criteria. Two TL3 fish species were caught, inland silverside (average length 105 mm) and threadfin shad (average length 88 mm). The average mercury concentration was 0.08 mg/kg, which exceeds the target of 0.05 mg/kg.

#### Large Fish Mercury Concentrations

Large fish integrate mercury concentrations over several years. Largemouth bass, the most frequently sampled large fish species for this TMDL, were also studied in Davis

Creek Reservoir. This reservoir was constructed in the early 1980's and first filled in the mid-1980's. It is downstream of a mercury mine. In 1985, the first largemouth bass were born in this reservoir. Researchers observed seasonal variations in adult largemouth bass mercury concentrations (Slotton et al. 1995).

Slotton et al. studied adult largemouth bass born in 1985 for five years, during which the average fish size increased from 20 grams to over 750 grams. These fish had very high mercury levels, an average of 2 mg/kg (wet wt., muscle) at the end of the study. In each year, bass muscle mercury concentrations declined during thermal stratification between spring and mid-summer. The explanation for the decline in fish mercury during thermal stratification is biodilution—growth dilution under lower mercury bioavailability. The general decline was interrupted in each of the years beginning in the late summer to mid-fall. This coincided with the juvenile bass seasonal increases.

Following turnover, when the bass became dormant, their muscle mercury concentrations remained steady or increased further during the winter. The explanation for the small increase in fish mercury during the winter is a combination of metabolic-based weight loss during November–March dormancy, coupled with low rates of mercury depuration (i.e. purification, removal of mercury from the body) (Slotton et al. 1995).

#### 2004 Large Fish and Human Consumption

In 2004, human health was protected for most consumers of fish from the reference reservoir, assuming consumption of an equal mix of TL3 and TL4 fish. This conclusion was based on the fish data analysis described in the following paragraphs.

Note from Section 5 that the wildlife numeric targets are also protective of human health. In this section, and the section below (2006 Large Fish and Human Consumption), we compare the average fish mercury concentrations to two thresholds, discussed in more detail in Section 5. The first threshold is the U.S. EPA's methylmercury criterion of 0.3 mg/kg. This criterion is based on the national default consumption rate of two meals per month of freshwater and estuarine (not ocean) fish. Ninety percent of the U.S. general population consumes less than this amount of fish; U.S. EPA considers it to be indicative of the average consumption among sport fishers. The second criterion is 0.2 mg/kg, which is based on a higher fish consumption rate specific to San Francisco Bay sport fishers of four meals per month of fish from the Bay. Because 0.2 mg/kg protects the 95$^{th}$ percentile of Bay sport fishers, it protects well over 99 percent of the Bay Area's population.

Adult largemouth bass and trout data provide an estimate of human prey fish mercury concentrations. The adult largemouth bass were collected from the reference reservoir on September 1, 2004. The trout were obtained directly from the hatchery in December 2006 from a shipment bound for reservoirs in Santa Clara County. Although the hatchery trout were collected in 2006, because they are raised in a controlled environment, it is reasonable to assume the 2006 mercury concentrations are representative of 2004 concentrations. We also assume that the trout mercury concentrations do not change significantly between stocking and human consumption because human fishing pressure coincides with stocking, as described below.

A study of stocked trout in Lafayette Reservoir, also in the San Francisco Bay Area, showed that

> the survival time of trout stocked during the summer may be quite limited.…The average weight of trout measured during the angler interviews was 114 g. Comparisons with the average weight of stocked trout during the same period (108 g) indicates that there is little growth of stocked trout prior to being caught. The low survival and/or growth is probably due to a combination of high epilimnion temperatures and predation by largemouth bass (Tetra Tech 1980).

This phenomenon has been observed at other sites. Reservoir biologists in the San Francisco Bay Area observe that most of the trout are caught soon after stocking, and the (human) fishers readily acknowledge timing their fishing activities to coincide with stocking (Gassel 2007).

The adult largemouth bass is TL4; the 2004 average mercury concentration in bass from the reference reservoir was 0.6 mg/kg. The hatchery trout is TL3; the average mercury concentration was 0.03 mg/kg. The average mercury concentration in a 50-50 mix of TL3 and TL4 is estimated as 0.3 mg/kg, equal to the U.S. EPA's methylmercury criterion. This is protective at a consumption rate of two servings per month of a 50–50 mix of TL3 and TL4 fish. However, it is not protective for people who consume four servings per month, nor is it protective in the seasons (i.e. late summer and fall) when largemouth bass are abundant, but trout are not abundant. Therefore, in 2006 we attempted to collect a wider range of fish species consumed by humans.

#### 2006 Large Fish and Human Consumption

In 2006, human health was protected for most consumers of fish from the reference reservoir, assuming consumption of an equal mix of TL3 and TL4 fish. This conclusion was based on the fish data analysis described in the following paragraphs.

The adult largemouth bass and pumpkinseed (a sunfish) from the reference reservoir, plus hatchery trout, provide an estimate of human prey mercury concentrations. Our sampling plan had called for 15 fish each of channel catfish, black crappie, sunfish, and stocked trout—species other than bass. The sample number of 15 was selected based on a statistical power analysis assuming similar variance as in 2004. However, we were only able to collect 15 adult largemouth bass and five pumpkinseed from the reference reservoir, in addition to 15 rainbow trout obtained directly from the hatchery. A possible reason for our poor fishing success is seasonal variations in abundance. As noted above, we were able to rule out excessive drawdown as a cause of low fish abundance, but perhaps fish populations vary seasonally in the reservoirs. For example, trout are not stocked after about May because they are not expected to survive the warm water in late summer.

The weighted-average mercury concentration in an equal mix of TL3 and TL4 fish consumed by humans (largemouth bass, pumpkinseed, and trout) was also 0.3 mg/kg in 2006, equal to the U.S. EPA's methylmercury criterion. This is protective at a consumption rate of two servings per month of an equal mix of TL3 and TL4 fish. However, it is not protective for people who consume four servings per month, nor is it protective in the seasons (i.e. late summer and fall) when largemouth bass are abundant, but trout are not abundant.

Next, we compare the reference reservoir adult largemouth bass mercury concentrations to those from throughout the western U.S.

#### COMPARISON OF MERCURY LEVELS IN WESTERN U.S. TO REFERENCE RESERVOIR

Adult largemouth bass mercury concentrations in the reference reservoir appear to be typical of concentrations found in the western U.S. (They are also typical of concentrations found in the San Francisco Bay Area; see Table 2.1.) We base this preliminary conclusion on the following data analysis.

We might expect that fish mercury concentrations in the reference reservoir would be elevated compared to those in other areas of the western U.S., because of its location in the mercury-rich Coast Range. On the other hand, Coast Range mercury deposits are very localized, and no ore-grade deposits were found in its watershed. In any case, the reference reservoir fish mercury concentrations are the best achievable—without active intervention (i.e. methylmercury and bioaccumulation controls).

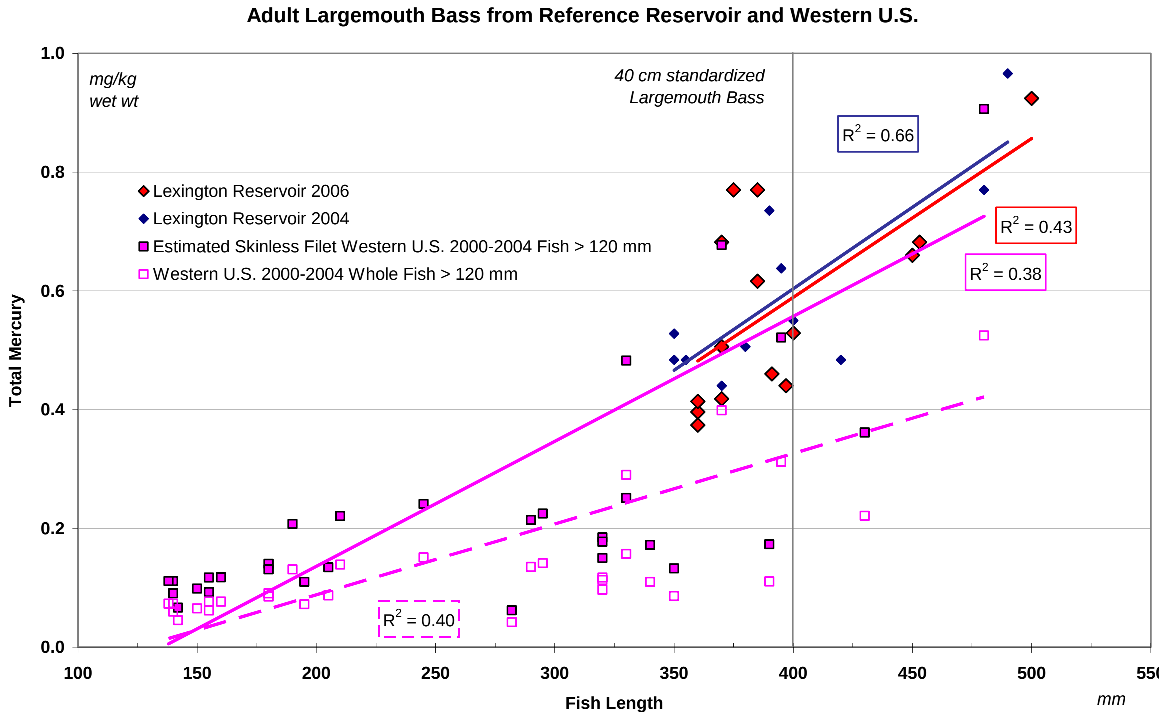
Researchers have recently published large fish (greater than 120 mm) mercury data from throughout the western U.S. (Peterson et al. 2007a). They collected and analyzed 2,707 large fish from 626 stream and river sites in 12 western U.S. states. In 57 percent of the assessed stream length, mercury concentrations in piscivorous (fish-eating, as compared to herbivores) species exceeded the U.S. EPA methylmercury criterion of 0.3 mg/kg. The lead author provided us with their adult largemouth bass data (Peterson 2007b). There are several differences between the data sets.

Adult largemouth bass from the Guadalupe TMDL study are larger than fish from throughout the western U.S. study. We have focused on collecting 400 mm bass, whereas only six of 31 bass from the western U.S. are greater than 350 mm. Guadalupe TMDL bass data are concentrations of mercury in muscle (skinless filet), whereas the western U.S. bass data are concentrations of mercury in whole fish. These researchers also evaluated the relationship between muscle and whole-body mercury concentrations. They found a statistically significant linear relationship based on an analysis of multiple species. They estimate that a whole-body total mercury concentration of 0.185 mg/kg equates to 0.30 mg/kg in muscle tissue (skinless filet, Peterson 2007b).

See Figure 7.12 for an illustration of the mercury concentrations in adult largemouth bass from the reference reservoir (diamonds) compared to the western U.S. (squares). We make the preliminary conclusion that adult largemouth bass mercury concentrations in the reference reservoir appear to be typical of concentrations found in the western U.S. This preliminary conclusion is based on a very small data set of fish of similar size. Also, other researchers have found a much higher proportion of mercury in largemouth bass muscle tissue compared to whole-body than in the multi-species relationship from the western U.S. study.

To move from a preliminary to a final conclusion requires, at a minimum: (a) obtaining more data from fish of similar sizes, (b) determining the relationship between muscle and whole-body mercury concentrations, and (c) performing a rigorous statistical analysis. The State Water Board is currently undertaking a two-year study of fish mercury from throughout California which may result in data which support just such a final conclusion, that reference reservoir fish mercury concentrations are typical of those found throughout the western U.S.

Peterson et al. concluded that the elevated fish mercury concentrations in the western U.S. are due to atmospheric deposition. This implies that, in addition to local TMDL implementation actions, atmospheric deposition of mercury needs to be addressed at the national and international scale.




## Figure 7.12 Largemouth Bass from Reference Reservoir and Western U.S.

Adult largemouth bass mercury concentrations in the reference reservoir (diamonds) appear to be typical of concentrations found in the western U.S. (squares).

One last form of mercury remains to be discussed in the reference reservoir: inorganic mercury.

### *INORGANIC MERCURY IN RESERVOIRS*

Mercury on the land surface is from several sources (mining waste, atmospheric deposition, and naturally occurring mercury in soil). Erodible surface soil and mercury mining waste are eroded by storm water, which transports inorganic mercury to receiving waters. In this manner, mercury is transported to reservoirs and accumulates in bottom sediments. (Above, we described the key to bioaccumulation of mercury from bottom sediments—dissolution, conversion to methylmercury, incorporation into algae and subsequent bioaccumulation.)

Three metrics are available to characterize these loads: (1) mass loads of total mercury, (2) mass loads of dissolved mercury, and (3) bottom sediment mercury concentrations. Mass loads were estimated in the *Final Conceptual Model Report* (Tetra Tech 2005c), but with low precision (a high precision monitoring program was cost-prohibitive and unnecessary for the conceptual model). We do not propose to examine mass loads further due to the low precision of the estimate. Additionally, a statistically robust set of impoundment bottom sediment samples were collected (see Figure 7.3) and provide a qualitative linkage from sources to targets (Section 7.1).

#### Bottom Sediment Total Mercury

Mercury concentrations in the reference reservoir bottom sediment samples (Tetra Tech 2005b; Table A.2) had a small range from 0.07–0.18 mg/kg dry weight, with average mercury of 0.1 mg/kg. More than half of the samples were 100% fines (silts and clays of less than 63 microns); percent fines ranged from 85–100%. As described above, these soil fines were transported to the reservoir as suspended sediment in storm water runoff.

In Section 8.4, *Nonurban Stormwater Runoff Total Mercury Concentrations*, we evaluate bottom sediment mercury concentrations as a potential allocation for upper watershed areas (i.e., non-urban and non-mineralized); these upper watershed areas are geologically distinct from the mineralized zone (i.e., Los Capitancillos ridge, and portions of Santa Teresa ridge).

***Key Points***

- Lexington Reservoir was selected as the reference reservoir for this TMDL because it receives no mercury mining waste or urban runoff. There are two mercury sources to the reference reservoir, naturally occurring mercury in soil, and atmospheric deposition.
- Small (prey) fish in the reference reservoir are not safe for consumption by wildlife. Similarly, larger fish that humans prefer are only appropriate for consumption at a rate of two servings per month of a 50–50 mix of TL3 and TL4 fish. However, this is not protective for people who consume four servings per month (the goal), nor is it protective in the seasons (i.e. late summer and fall) when largemouth bass are abundant, but trout are not abundant. Methylmercury reached a peak concentration of 2.6 ng/l in the reference reservoir in 2004. The average total mercury in the reference reservoir bottom sediments is 0.1 mg/kg; these sediments are primarily soil fines (silts and clays less than 63 microns).
- The linkage between sources (mining waste, urban runoff, atmospheric deposition, and naturally occurring mercury in soil) and the numeric targets (fish tissue methylmercury concentrations) is not direct. As illustrated in Figure 7.1, the sources and the numeric targets are linked by the sites where methylmercury is produced.
- The wet season is largely a time of transport of inorganic particulate mercury, whereas methylation and bioaccumulation largely occur in the dry season when and where the critical condition of low oxygen (anoxic conditions) occurs. One implication of the linkage is that both dissolved and total mercury loads must be reduced; mining waste erosion controls will keep mercury on the landscape and out of the aquatic system where it may dissolve.
- Methylation principally occurs in the oxygen-depleted depths of impoundments. “Impoundments” are engineered structures, such as dams, drop structures, and former quarries, which cause water to pond—and are very different from natural conditions as there are no natural deep lakes in this watershed.
- Methylmercury bioconcentrates as it moves up the food chain from algae to zooplankton to prey fish and to predator fish (Figure 7.8). The largest single jump in concentration occurs from the water to algae.
- Although there may be sites for methylation in the stream and river channels, as discussed in “mercury transport and linkage” above, their total contribution to methylmercury production is much smaller than the exports from the reservoirs and Lake Almaden during the dry season. This suggests that that reducing methylmercury production to attain TMDL targets in reservoirs downstream of mercury mines and Lake Almaden will likely also attain targets in downstream waters.

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# 8. Allocations and TMDLs

This section presents allocations, total maximum daily loads (TMDLs), and integration between the Guadalupe River watershed and San Francisco Bay mercury TMDL projects. The allocations describe the reductions needed in mercury loads by source. In this section, we also establish the TMDLs for impaired waters. These allocations and TMDLs implement the mercury water quality objectives in certain waters of the Guadalupe River watershed (see Figure 1.2). A summary table of the allocations (Table 8.5) is provided in Key Points at the end of Section 8, followed by a watershed map illustrating the allocations (Figure 8.1).

As shown by the Linkage Analysis (Section 7), mercury bioaccumulation in the Guadalupe River watershed cannot be reduced unless loads of dissolved and total mercury and methylmercury production are reduced. Reductions in total mercury are also necessary to meet the legacy and urban stormwater runoff allocations that the San Francisco Bay mercury TMDL assigns to the watershed. Allocations are based on goals of (a) eliminating inputs of mercury caused by anthropogenic activities, particularly mining and urban stormwater runoff, and (b) minimizing the transformation of mercury to methylmercury caused by anthropogenic activities, particularly the operation of impoundments (see Section 8.2 for the definition of impoundments).

The allocations proposed below are concentration limits within the watershed. The total mercury allocations are equal to the mass load allocations assigned by the San Francisco Bay mercury TMDL to mercury mining legacy, urban stormwater runoff, nonurban stormwater runoff, and atmospheric deposition sources. Mass loads and concentrations of total mercury are expected to fluctuate with the magnitude of precipitation, flow, and resulting soil erosion from the land surface and from the banks, floodplains, and bottoms of creeks and rivers. The total mercury allocations are intended to represent long-term averages and account for long-term variability, including seasonal variability.

Achieving the allocations detailed below will be part of a two-phase TMDL implementation process described in the Implementation Plan (Section 9). In general, the goals for the first phase of implementation are to (a) implement effective source control measures at mercury mine sites, (b) complete studies to reduce discharge of mining waste accumulated in downstream beds, banks, and floodplains, and (c) complete studies of methylmercury and bioaccumulation controls in reservoirs and lakes. The goal for the second 10-year phase of implementation is to achieve the watershed fish tissue targets and the total mercury load allocation assigned by the San Francisco Bay mercury TMDL. Throughout both phases, the mercury load, concentrations, and bioaccumulation will be monitored to ensure that total and methylmercury levels have declined and fish targets are attained. As described in Section 9 (Monitoring and Implementation), monitoring may be undertaken in a coordinated effort by many entities. Guiding both phases, and remaining central to the implementation process, will be the allocations for each source described below.

### *8.1 Mining Waste Total Mercury Allocations*

The goal for the mining waste allocations are to eliminate inputs of mercury to surface waters caused by anthropogenic activities (i.e., mining) to restore beneficial uses. This goal is consistent with the Basin Plan's (Chapter 4.21 *Implementation Plan*) goals for mines and mineral producers to "…restore and protect beneficial uses of surface waters now impaired or threatened with impairment resulting from past or present mining activities." It is also consistent with the Clean Water Act requirement that "the TMDL and associated wasteload and load allocations must be set at levels necessary to result in attainment of all applicable water quality standards… 40CFR130.7(c)(1)."

#### *DEFINITIONS*

Mining waste is defined in the California Water Code §13050 (q)(1) as "all solid, semisolid, and liquid waste materials from the extraction, beneficiation, and processing of ores and minerals. Mining waste includes, but is not limited to, soil, waste rock, and overburden, as defined in Section 2732 of the Public Resources Code, and tailings, slag, and other processed waste materials…" The mining waste allocations apply to mining waste as defined above, including ore piles, soil under processing sites, stormwater runoff from processing facilities and equipment, and other process areas and equipment impacted by mine operations and exposed to stormwater such that mercury may be transported to surface waters.

Mining waste is located in the New Almaden Mining District (defined in Section 3.4); and at the Guadalupe, Santa Teresa, and Bernal mercury mines. Due to wet season transport over more than a century, mining waste is also located in the downstream bed, banks, and floodplains of Guadalupe, Alamitos, and Calero creeks, and the Guadalupe River. These areas are referred to as downstream "depositional" mining waste source areas.

"Erodible" means material readily available for transport by stormwater runoff to surface waters . Soil fines on the landscape become suspended sediments when they are transported by stormwater runoff to surface waters. Erosion is assumed to be controllable. Fines are the silt and clay portion of soil that is less than 63 microns in diameter. Mercury concentrations on suspended sediment are best characterized by the annual median.

#### *RECOMMENDED MINING WASTE TOTAL MERCURY ALLOCATIONS*

Water Board staff proposes two total mercury mining waste allocations as follows:

- 0.2 mg mercury per kg mercury mining waste (dry wt., median) in erodible mercury mining waste from the New Almaden Mining District, and Guadalupe, Santa Teresa, and Bernal mercury mines; this allocation shall be measured in fines less than 63 microns in diameter; and
- 0.2 mg mercury per kg erodible sediment (dry wt., median) discharged from depositional areas in creeks that drain mercury mines.

The mining waste allocations are equal to the TMDLs, except that they are 'medians' rather than 'annual medians' because of temporal differences in sampling. Measurements of mercury in erodible soil fines are collected at one time (on the date when surface soil is sampled), whereas measurements of mercury in suspended sediments are averaged over a year of stormwater runoff. The analysis for these allocations is presented below.

#### *POTENTIAL MINING WASTE ALLOCATIONS*

Water Board staff considered forms of mercury appropriate for this allocation. The principal concern with mining waste is wet season stormwater transport of inorganic mercury to surface waters. Implementation actions taken to prevent the erosion and transport of mining waste from the landscape to surface waters will effectively address dissolved mercury from mining waste; methylmercury production is addressed as a separate allocation below. Therefore, the mining waste allocation is for total mercury.

We also considered several options for the mining waste allocations and associated compliance monitoring, such as a mass load, restoring to pre-mining conditions, and based on data from the reference reservoir. Examples and evaluations of these allocations and compliance monitoring are provided below.

##### Potential Mass Load Allocations

Examples of mass load allocations are the total maximum annual load that the San Francisco Bay mercury TMDL assigns to the Guadalupe River watershed (SFBRWQCB 2004), and the 95 percent mass load reduction assigned to mines in the Cache Creek watershed (CVRWQCB 2004b.) However, the Source Analysis provided loads for only one year (2004). Especially for loads from the upper watershed, there is high uncertainty in these estimates (see Section 4.3). Compounding this uncertainty, the loads vary widely from year-to-year depending on rainfall. Therefore, it would be impractical to regulate on annual or daily mass loads of total mercury. Therefore, we recommend allocations in a metric that has much less interannual variability; hence we recommend concentration-based allocations.

Additionally, compliance monitoring for a mass load would require considerable precision for discharges from many creeks in the several-thousand-acre New Almaden Mining District, and separately from Guadalupe, Santa Teresa, and Bernal mercury mines, and downstream creek beds, banks, and floodplains. Due to the wide range in annual precipitation, monitoring would be required over several years. Presumably, the 95 percent mass load reduction approach to allocations would require even greater monitoring precision. We propose that the funding for these monitoring efforts would be better spent on implementation to restore beneficial uses.

##### Potential Allocations Based on Conditions Prior to Mining

Examples of allocations to restore the landscape to pre-mining conditions include establishing pre-mining surface soil mercury concentrations to use as mine site cleanup goals (CVRWQCB 2004b), or mineralized zone perimeter sediment mercury concentrations to use as mine site cleanup goals (CVRWQCB 2004a). Data are lacking to justify allocations in the Guadalupe River watershed based on pre-mining conditions. (See Section 9.10 regarding establishing cleanup goals [not allocations] based on pre-mining conditions.)

##### Potential Allocation Based on Reference Reservoir

We considered an allocation based on sediment mercury concentrations in the reference reservoir (Lexington Reservoir, see Section 7.6). Bottom sediment concentrations in the reference reservoir are 0.1 mg/kg total mercury in fines (less than 63 microns). These soil fines were transported to the bottom of the reservoir as suspended sediment in stormwater runoff, and hence represent surface soil mercury concentrations. This allocation would correspond to undisturbed conditions . However, the reference reservoir is located outside the mercury-enriched portion ("mineralized zone") of the watershed. Therefore, the reference reservoir does not adequately characterize pre-mining surface soil mercury concentrations in the mineralized zone of the watershed. Even recognizing that New Almaden was the world's deepest mercury mine because ores were located far underground, surface soils in the mineralized zone are likely enriched in mercury. Therefore, we reject this potential allocation. Recommended Allocation Based on San Francisco Bay Mercury TMDL

We propose a total mercury allocation of 0.2 mg/kg (dry weight, median) to mercury mining waste. This allocation is based on the San Francisco Bay mercury TMDL suspended sediment mercury target of 0.2 mg/kg (dry weight, annual median) to attain fish tissue and bird egg targets protective of Bay wildlife beneficial uses.

Water Board staff proposes to evaluate attainment of the mining waste allocations through Water Board oversight of selection, design, construction, and operations and maintenance of best management practices for erosion control, see Section 9 (Implementation).

## *8.2 Impoundment Methylmercury Allocation*

The goal for allocations to impoundments (see 'definitions' below) is to operate these engineered features in a manner such that they attain TMDL targets. This goal is consistent with the Clean Water Act requirement that "the TMDL and associated wasteload and load allocations must be set at levels necessary to result in attainment of all applicable water quality standards… 40CFR130.7(c)(1)."

#### *POTENTIAL ALLOCATIONS*

Water Board staff proposes total methylmercury allocations to reservoirs and lakes. We evaluated numerous potential allocations in the process of forming this recommendation. In the sections below, we define terms used in this section, explain the basis of the recommendation, and discuss other potential allocations and why we rejected them.

#### Definitions

Impoundments occur behind engineered structures and anthropogenic alterations to the landscape that pond water. Engineered structures include dams, which impound water in reservoirs and artificial lakes, and flood control structures, such as drop structures, which typically form smaller impoundments. Anthropogenic alterations to the landscape include vegetation that ponds water. As described in Section 4 (Source Analysis), prior to the mining era, there were no lakes or other large natural impoundments in the Guadalupe River watershed. Deep impoundments (reservoirs and lakes) undergo thermal stratification in the dry season; shallow impoundments do not stratify.

Peak methylmercury is the term we use to describe the dry season maximum methylmercury concentration in the hypolimnion of reservoirs and lakes. This seasonal peak is also the annual peak (see Section 7.2).

#### Recommended Methylmercury Allocation for Reservoirs and Lakes

Staff proposes an allocation of 1.5 ng/l peak total methylmercury in the hypolimnion of reservoirs and lakes downstream of mercury mines. The proposed allocation is applicable to Guadalupe Reservoir, Almaden Reservoir, Calero Reservoir, and Lake Almaden. This allocation is based on the peak methylmercury concentration in the reference reservoir, and is calculated to attain TMDL targets by minimizing the transformation of mercury to methylmercury caused by anthropogenic activities. The analysis for this allocation is presented below.

### *DEVELOPMENT OF METHYLMERCURY ALLOCATIONS TO RESERVOIRS AND LAKES*

In developing the recommended allocation, we considered the following approaches: (a) national default or site-specific data, (b) annual average or peak hypolimnion methylmercury concentrations, (c) depth-averaged or depth-specific concentrations, or (d) dissolved or total methylmercury. We present staff's analysis of the merits of these different approaches to allocations in the sections below.

#### (a) National Default or Site-Specific Data

We reject the default approach, which consists of using national default data, because we have a large data set from 2004 of reservoir aqueous methylmercury data in the Guadalupe River watershed reservoirs. Instead, we propose an allocation based on site-specific data from the reference reservoir (see Calculation of Methylmercury Allocations for Reservoirs and Lakes).

The default approach results in an allocation of 0.04 ng/l dissolved methylmercury, annual average, to the entire deep impoundment. This is calculated by dividing the desired fish tissue concentration by the default BAF (BAFs are defined in Section 7.4). The desired fish tissue concentration is the wildlife target for TL3 fish 5-15 cm in length of 0.05 mg/kg. The default BAF is from the U.S. EPA methylmercury criterion for the protection of human health. The U.S. EPA calculated a draft national BAF of 1,300,000 on average for dissolved methylmercury in lakes and mercury in TL3 fish (Table A-1, USEPA 2001). Dividing the target by the BAF (0.05 mg/kg divided by 1,300,000) and multiplying by $10^6$ (to convert from milligrams to nanograms) yields 0.04 ng/l dissolved methylmercury, annual average, to the entire deep impoundment. We previously employed this default approach for Soulajule Reservoir in the Walker Creek watershed where we have no reservoir aqueous methylmercury data (SFBRWQCB 2007).

#### (b) Annual Average or Peak Hypolimnion Methylmercury Concentrations

Staff proposes allocations of peak, rather than annual average, hypolimnion methylmercury concentrations. From the reference reservoir depth profiles in Figures 7.9a–c, we observe well-mixed conditions characterized by nearly constant depth profiles during winter and fall (1/12/04–3/04/04, and 9/27/04–12/02/04). Weak stratification characterized by small changes with depth occurs in the spring (3/18/04 - 5/13/04). Strong stratification during the dry season is characterized by an abrupt shift in the depth profiles (5/25/04 – 9/02/04). If the key to controlling hypolimnion methylmercury production is oxygen—and it does appear to be the key—then we observe that oxygen inputs are only necessary during stratification. Therefore, we eliminate annual average methylmercury concentration as a potential allocation, and instead propose the peak methylmercury concentration for the allocation.

### (c) Depth-Averaged or Depth-Specific Concentrations

Staff proposes depth-specific rather than depth-averaged allocations. (During thermal stratification, the warmer top water layer is the epilimnion, the middle transition zone is the metalimnion, and the cooler deeper water is the hypolimnion.) This conclusion was based on the analysis described in the next paragraph.

The hypolimnion is the portion of the water body in which methylmercury concentrations increase greatly during the dry season. For example, the total methylmercury concentration in the Guadalupe Reservoir hypolimnion increased during stratification from about 0.9 ng/l to nearly 13 ng/l (measured at the outlet, Appendix A, Table A.6). In contrast, the Guadalupe Reservoir epilimnion samples collected during the dry season at one-foot depth remained fairly constant at less than 0.5 ng/l.

The Santa Clara Valley Water District is currently studying hypolimnion methylmercury controls. A further reason to reject depth-averaged allocations is practical; staff is unaware of any efforts to develop methylmercury production controls for the epilimnion or metalimnion. Therefore, we eliminate depth-averaged methylmercury concentrations as a potential allocation, and instead propose a depth-specific allocation to the hypolimnion.

### (d) Dissolved or Total Methylmercury

Staff proposes total methylmercury rather than dissolved methylmercury allocations, because total also protects consumers of benthic organisms as well as consumers of fish. This conclusion was based on the analysis described in the following paragraphs.

Dissolved and total methylmercury measurements were collected by Tetra Tech from reservoirs during the July 2003 synoptic survey sampling event, the 2004 wet season sampling, and the 2004 dry season depth profiles in two reservoirs (Table A.6.) Only total methylmercury measurements were collected by Light, Air and Space from the reference reservoir (Lexington) throughout 2004 (Appendix A, Table A.3b).

Bioavailable methylmercury includes both that in the dissolved form (accumulated principally by phytoplankton) and that in the particulate form, such as in or adsorbed to phytoplankton (accumulated principally by zooplankton.) Dissolved methylmercury is considered a better measure of the first step in bioaccumulation from water to phytoplankton and eventually to fish—that is why U.S. EPA uses dissolved methylmercury in their calculation of BAFs (see Default Approach for Methylmercury Allocation, above.)

Because total methylmercury is inclusive of dissolved methylmercury, and because total methylmercury protects predators of fish and benthic organisms, we propose a total methylmercury allocation. Total methylmercury is bioaccumulated by benthic organisms, and affects the benthic community and their predators, including people who consume crayfish. Therefore, we eliminate dissolved methylmercury concentrations as a potential allocation, and instead propose a total methylmercury allocation.

In summary, we propose an allocation that is based on the following factors: (a) site-specific data, (b) peak concentrations, (c) depth-specific to the hypolimnion, and (d) total methylmercury concentrations. We present staff's calculation of the allocation below.

#### CALCULATION OF METHYLMERCURY ALLOCATION FOR RESERVOIRS AND LAKES

Note from Section 7.6 that total methylmercury reached an estimated peak concentration of 2.6 ng/l in the hypolimnion of the reference reservoir in 2004. This is the only available estimate of peak methylmercury concentrations in the reference reservoir. Also, as noted in Section 7.6, fish tissue targets were not attained in the reference reservoir. Therefore, to calculate methylmercury allocation for reservoirs and lakes, it is necessary to adjust the measured peak methylmercury concentration down to a lower concentration that will attain the wildlife target. The steps to calculate the allocation are to first calculate a bioaccumulation factor (BAF) based on measurements, then divide the target fish mercury concentration by the BAF.

Staff calculated a BAF (see Equation 7.1) based on the reference reservoir. We divided the November 2006 average fish mercury concentration (0.083 mg/kg) by the 2004 peak methylmercury concentration (2.6 ng/l), and multiplied the result by $10^6$ ng/mg, which yields a BAF of 31,923 l/kg. Staff selected an explicit margin of safety of 5 percent, which yields a fish target of 0.0475 mg/kg. The methylmercury allocation is calculated by dividing this fish tissue target (0.0475 mg/kg) by the BAF (31,923 l/kg), and multiplying the result by $10^6$ ng/mg. This yields a methylmercury concentration of 1.5 ng/l to attain the wildlife target, with a 5 percent margin of safety.

We note that sampling will be required to evaluate compliance with the allocation. Hypolimnion samples are easier, safer, and less time-consuming to collect from the outlet. Therefore, we developed this allocation for the outlet, to be applicable to discharge samples collected from Guadalupe, Almaden, and Calero reservoirs. However, Lake Almaden discharges from the surface. Consequently, hypolimnion samples from Lake Almaden will require a boat.

##### Confirm the Allocation Is Appropriate

Staff compared the proposed allocation to influent data and confirmed the allocation is appropriate. It would not be appropriate if influent methylmercury concentrations were similar to the proposed allocation. This conclusion was based on the analysis described in the following paragraphs.

We evaluated available dry season influent methylmercury concentrations to confirm that influent loadings are not as significant as methylmercury produced within the reservoirs and lakes. Dry season data was collected upstream of impoundments from a mine seep and Deep Gulch Creek during the 2003 Synoptic Survey fieldwork (Tetra Tech 2003a). Total methylmercury concentrations were 0.131 and 0.201 ng/l, respectively, well below the levels attained in the reservoirs and lakes. This data, together with the calculations in Section 4.4 that show 3 to 10 times as much methylmercury accumulated in the hypolimnion as the epilimnion, demonstrate that the allocation is appropriate in the dry season.

Similarly, our analysis of wet season data demonstrates that the allocation is appropriate. Wet season data was collected in numerous tributaries to Lexington, Guadalupe, Almaden, and Calero reservoirs (Tetra Tech 2005a). Maximum creek (influent) total methylmercury concentrations ranged from 0.141 to 0.289 ng/l; maximum total methylmercury discharge concentrations ranged from 0.072 ng/l from Lexington to 0.704 ng/l from Guadalupe. These wet season influent and discharge methylmercury concentrations are lower than the proposed allocation, and considerably lower than the seasonal maximum in Guadalupe Reservoir, so we conclude that the allocation is appropriate.

#### Increasing Assimilative Capacity for Methylmercury

An additional factor staff considered in developing methylmercury allocations is bioaccumulation control strategies. In other words, can the bioaccumulation—rather than the production—of methylmercury be controlled? In TMDL lingo, can the assimilative capacity for methylmercury be increased? These allocations do not account for food web differences between waters nor year-to-year variability. Some studies indicate that given the same methylmercury production rates, if biological productivity is increased, especially at the lowest trophic levels, then methylmercury bioaccumulation will be decreased (in a sense, diluted) (Chen 2005). We propose special studies (Section 9.10) to provide site-specific information. In Adaptive Implementation (Section 9.8), we describe how we propose to use the study results to refine the methylmercury allocation, as necessary.

### *ALTERNATIVE ALLOCATIONS FOR IMPOUNDMENTS*

In this section, we present brief descriptions of other potential allocations to impoundments, and why we rejected them.

#### Alternative 1 – Total Mercury Allocations

Staff does not propose total mercury allocations for shallow or deep impoundments. The main concern with mercury in the aquatic system is its transformation to methylmercury and bioaccumulation. In This TMDL project, we are focusing on the main concern in impoundments—methylmercury.

An additional reason to reject total mercury allocations to impoundments is that they act as sediment traps (except possibly during episodic high flow events when accumulated sediment may be scoured and discharged). The deep impoundments are particularly efficient sediment traps—reportedly, Almaden Reservoir's outlet structure had to be raised over 30 feet due to sediment accumulation.

An impoundment can be modeled as a simple, one-box model. Sediment flows into the impoundment, mixes, and settles at the bottom. The proportion that settles is dependent on the water velocity. Sediment accumulates more readily under low water velocity, which is nearly always the case in the deep impoundments, as evidenced by their high sediment accumulation rate. We anticipate that the mining waste total mercury allocations, and the accompanying implementation plan, will reduce the transport of mercury-laden sediment into the reservoirs. Because clean sediment will continue to be transported from non-mined areas, it will, in effect, dilute the mercury concentration in the top layer of reservoir bottom sediments. The resulting effect—lower mercury concentrations in bottom sediments—is desirable (see Figure 7.2).

A further reason to reject total mercury allocations to impoundments is that it would unnecessarily duplicate the mining legacy allocation assigned to this watershed by the San Francisco Bay mercury TMDL. For flood control purposes the Santa Clara Valley Water District regularly undertakes removal of mercury-laden sediment accumulated in shallow impoundments and depositional areas, which contributes to attaining the mining legacy mass allocation (see Section 8.6) established by the San Francisco Bay mercury TMDL. Therefore, staff does not propose total mercury allocations for impoundments.

Guadalupe Reservoir is a potential exception because “a known mine was inundated by the reservoir and there were small mines along its banks (Summers 2007)”. Consequently, Guadalupe Reservoir may be affected by or discharge mercury from this mine and ore processing site. Alternatively, potentially large volumes of mining waste may have been transported to this reservoir from “Los Capitancillos Creek below the America Mine, where a post-mining landslide occurred (Summers 2007)”. In any case, the dilution effect is also expected for Guadalupe Reservoir.

#### Alternative 2 – Dissolved Total Mercury Allocations

Staff does not propose dissolved total mercury allocations for shallow or deep impoundments because the main concern is methylmercury. Staff evaluated options for allocations related to mercury transformations from the inorganic solid state to dissolved mercury, then to methylmercury, and subsequent bioaccumulation. As discussed in Section 7.5, we are unsure whether it is loads of dissolved mercury from the preceding wet season which are methylated, or whether dissolution of mercury from bottom sediments is methylated. For this reason, and because erosion control (see Section 9.3) will keep inorganic solid mercury on the landscape and out of the aquatic system where it may dissolve, we do not propose dissolved mercury allocations.

#### Alternative 3 – Shallow Impoundment Methylmercury Allocations

Staff proposes studies to support methylmercury allocations for shallow impoundments. (Shallow impoundments do not undergo thermal stratification in the dry season.) The need for these studies is contingent on the effectiveness of deep impoundment control measures. If needed, the studies will be undertaken in Phase 2 of implementation.

Mercury may be transformed to methylmercury nearly anywhere anoxic conditions occur (see Section 7.2). Anoxic locations are potentially widespread in this watershed, including in shallow impoundments. Methylmercury production in this watershed has only been studied in deep impoundments, and appears to be a key factor in methylmercury production, uptake in the deep impoundments themselves, transport downstream, and downstream uptake. Therefore, staff proposes methylmercury allocations to deep impoundments.

Staff proposes studies of methylmercury production and bioaccumulation in shallow impoundments. Many shallow impoundments in urbanized areas exist due to controllable human activities. Methylmercury production and bioaccumulation have not yet been studied sufficiently in this watershed to support a methylmercury allocation to shallow impoundments. We propose these special studies (see Section 10), to be undertaken if methylmercury and bioaccumulation controls in the deep impoundments do not attain targets downstream.

### *8.3 Urban Stormwater Runoff Total Mercury Allocation*

The mercury in urban stormwater runoff results in part from controllable urban sources, such as improperly discarded fluorescent lights, electrical switches, thermometers, and other mercury-containing devices, and from historical and ongoing industrial activities (SFBRWQCB 2004.) Atmospheric deposition and naturally occurring mercury in background soils, which are assumed to be difficult to control, also contribute to the mercury in urban stormwater runoff. The estimated suspended sediment load discharged from the Guadalupe River watershed to San Francisco Bay is 44 million kilograms per year (M kg/yr), of which 36 M kg/yr is from urban stormwater runoff (SFBRWQCB 2004). Sediment load multiplied by the San Francisco Bay mercury TMDL target concentration of 0.2 mg/kg total mercury in suspended sediment (SFBRWQCB 2004) yields the Bay TMDL urban stormwater runoff wasteload allocation of 7.2 kilograms per year total mercury to be attained within 20 years. The Bay TMDL interim wasteload allocation to urban stormwater runoff is halfway between the current load and the allocation, 11 kilograms to be attained within 10 years.

The Bay mercury TMDL is allocated by mass. Staff proposes to allocate the TMDL of mercury to the Guadalupe River watershed by the proportionally equivalent concentration.

This allocation also applies to a small section of Los Gatos Creek waters that receive urban runoff. These waters include Vasona Lake and Los Gatos Creek and its tributaries between Vasona Lake and Lexington Dam (the upper limit of urban stormwater runoff discharges to Los Gatos Creek).

This allocation applies to the Santa Clara Valley Urban Runoff Pollution Prevention Program, currently regulated under NPDES Permit No. CAS029718. This permit is revised and reissued approximately every five years, and the permit number changes accordingly.

#### *RECOMMENDED URBAN STORMWATER RUNOFF TOTAL MERCURY ALLOCATION*

Staff recommends an allocation of 0.2 mg mercury per kg suspended sediment (dry weight, annual median) to urban stormwater runoff in the Guadalupe River watershed.

### *8.4 Nonurban Stormwater Runoff Total Mercury Allocation*

Erosion of background, non-mineralized soil is a source of mercury. This source, naturally occurring mercury in soil, is distinct from mining waste (see Section 4). Because erosion from non-urban background areas of the watershed may be exacerbated by grazing, road cuts, or other anthropogenic activities, the loads are somewhat controllable. In the San Francisco Bay mercury TMDL, the Guadalupe River watershed's suspended sediment load was estimated to be 44 M kg/yr, of which 8.5 M kg/yr is derived from non-urban stormwater runoff (SFBRWQCB 2004). The estimated mercury sediment concentration in Bay Area open space today of 0.06 mg/kg is close to the estimated pre-mining background concentration of 0.08 mg/kg in San Francisco Bay, and well below the San Francisco Bay mercury TMDL target of 0.2 mg/kg (SFBRWQCB 2004). Therefore, the San Francisco Bay mercury TMDL nonurban stormwater runoff load allocation is the current load. The Guadalupe sediment load multiplied by the estimated open space mercury concentration of 0.06 mg/kg total mercury in suspended sediment yields the Bay TMDL nonurban stormwater runoff load allocation of 0.5 kilograms per year of total mercury.

The Bay mercury TMDL is allocated by mass. Staff proposes to allocate the TMDL of mercury to the Guadalupe River watershed by the proportionally equivalent concentration, the measured concentration of mercury in bottom sediments of the reference reservoir (Section 7.6). This measured concentration is 0.1 mg/kg, similar to the estimated pre-mining background concentration of 0.08 mg/kg, and well below the San Francisco Bay mercury TMDL target of 0.2 mg/kg (SFBRWQCB 2004). This allocation also applies to waters in the Los Gatos Creek watershed upstream of Lenihan Dam, including Lexington Reservoir, Lake Elsman, and Los Gatos Creek and its tributaries upstream of Lexington Reservoir.

#### *RECOMMENDED NONURBAN STORMWATER RUNOFF TOTAL MERCURY ALLOCATION*

Staff recommends an allocation of 0.1 mg mercury per kg suspended sediment (dry weight, annual median) to nonurban stormwater runoff in the Guadalupe River watershed.

## *8.5 Atmospheric Deposition Total Mercury Allocation*

Deposition from the atmosphere is minimal relative to other loads in the watershed. As described in Section 4 (Source Analysis), the load of mercury from atmospheric deposition onto land surface has not been quantified separately from the background soil load, and therefore is included in the nonurban stormwater runoff load allocation above. However, there is also direct atmospheric deposition onto waters, which is addressed by this load allocation. No reductions are called for partly because this load is reflected in the mining waste allocations of 0.1 & 0.2 mg/kg mercury (dry weight, annual median) in erodible soil fines (see Sections 7.6 and 8.1).

Mercury in the atmosphere enters the watershed during dry weather (dry deposition) and rainy weather (wet deposition). To determine the mercury load associated with dry and wet deposition, the Regional Monitoring Program for Trace Substances collected ambient air and precipitation samples at three Bay Area sites. The study estimated the average dry and wet deposition rate to be 23.2 micrograms of mercury per square meter per year (SFEI 2001). About 1 percent of the 170-square-mile watershed is water surface, which is approximately 4.8 million square meters.

The deposition rate multiplied by the area yields the existing load of 0.1 kilograms per year of total mercury. Because the potential to reduce deposition by controlling local sources is believed to be limited, and because reductions in the global atmospheric pool are beyond the scope of this TMDL project, the atmospheric deposition load allocation is the existing load. It is anticipated that remediation of the New Almaden Mining District will reduce atmospheric inputs from local and regional sources, but no estimates are available.

The Bay mercury TMDL is allocated by mass. Staff proposes to allocate the TMDL of mercury to the Guadalupe River watershed by the proportionally equivalent concentration.

#### *RECOMMENDED ATMOSPHERIC DEPOSITION TOTAL MERCURY ALLOCATION*

Staff recommends an allocation of 23.2 micrograms of mercury per square meter per year to atmospheric deposition directly to waters in the Guadalupe River watershed.

### *8.6 Total Maximum Daily Loads (TMDLs)*

In Section 8.6, we present the TMDLs and the following related analyses: assimilative capacity, margin of safety, seasonal variations and critical conditions, and daily load expressions.

TMDLs are "[t]he sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background. … TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure" (Code of Federal Regulations, Title 40, §130.2[i]). We are establishing concentration-based TMDLs in accordance with this provision of the Clean Water Act.

The TMDLs of mercury to the impaired waters of the Guadalupe River Watershed are the combination of concentration-based allocations proposed in Sections 8.1–8.5, and summarized on Table 8.1.

**Table 8.1 Total Maximum Daily Loads**

| TMDL | Impaired Waters |
|---|---|
| 0.2 mg mercury per kg suspended sediment (dry wt., annual median) | **Creeks and river**:<br>Guadalupe Creek<br>Alamitos Creek<br>Guadalupe River |
| 1.5 ng total methylmercury per liter water (seasonal maximum, hypolimnion) | **Reservoirs and Lakes**:<br>Guadalupe Reservoir<br>Almaden Reservoir<br>Calero Reservoir<br>Lake Almaden |

#### *ASSIMILATIVE CAPACITY*

Assimilative (load) capacity is "[t]he greatest amount of loading that a water can receive without violating water quality standards" (Code of Federal Regulations, Title 40, §130.2[f]). The assimilative capacity for mercury is equal to the concentration-based TMDLs and allocations, which are summarized on Tables 8.1 and 8.5.

#### *MARGIN OF SAFETY*

TMDL analyses must incorporate a margin of safety to address potential uncertainties. The margin of safety is intended to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. This report relies on an explicit five percent margin of safety in the methylmercury allocation.

The margin of safety can be derived either explicitly or implicitly. Providing an implicit margin of safety would involve using conservative assumptions (assumptions more likely to be over-protective than under-protective) throughout the analysis. Alternatively, an explicit margin of safety involves reserving a specific mercury load allocation for the margin of safety.

The primary margin of safety is provided by an explicit five percent margin in the methylmercury allocation (see Section 8.2.) A secondary, and implicit, margin of safety is provided by a conservative assumption in a water quality objective, which was set at the most protective level in TL3 fish of 15 cm (see Section 5).

This TMDL project indicates that source control alone is insufficient to attain targets within the watershed. However, This TMDL project calls for mining waste and urban runoff source control actions to protect San Francisco Bay. Reducing mercury in impoundment bottom sediments to attain targets (without methylation controls) would likely require cleanup of mining waste to mercury concentrations lower than background soil mercury concentrations. An alternative, but similarly impractical, method for achieving fish tissue targets is to remove all impoundments from operation.

Therefore, Water Board staff proposes to rely on the development of new and innovative methylmercury and bioaccumulation control methods to attain targets. These promising control methods are based on adapting nutrient controls developed for reservoirs (e.g., oxygenate the hypolimnion for taste and odor control). Methylation control provides a sufficient margin of safety so that, as explained in Section 8.2, the fish tissue targets are likely to be met in and downstream of Guadalupe, Almaden, and Calero reservoirs, and Lake Almaden. In other words, staff is optimistic that targets will be met in Guadalupe and Alamitos creeks, and in the Guadalupe River, by reducing methylmercury production in the deep impoundments (reservoirs and lakes) alone.

#### *SEASONAL VARIATIONS AND CRITICAL CONDITIONS*

Federal regulations require TMDLs to account for seasonal variations and critical conditions. The possible factors to consider for seasonal variability include pollutant loads, beneficial use impairment, and ambient concentrations of total mercury and methylmercury in water and sediment. Seasonal variability in loads is a key feature in the Guadalupe River watershed, and it is discussed extensively in Section 7 (Linkage). Essentially, in the wet season, total mercury is transported in stormwater, whereas methylation and bioaccumulation largely occur in the dry season when and where the critical condition of low oxygen (anoxic conditions) occurs. The allocations proposed in Section 8 are intended to address seasonal variations and critical conditions.

#### *DAILY LOAD EXPRESSIONS*

We provide the following daily load expressions in light of a recent court decision and draft U.S. EPA guidance, despite the fact that a daily or average daily TMDL is not appropriate for this TMDL project. The District of Columbia (D.C.) Circuit Court of Appeals issued a decision in *Friends of the Earth, Inc. v. EPA, et al.*, No. 05-5015 (D.C. Cir. 2006), in which the D.C. Circuit held that two TMDLs for the Anacostia River (one established by U.S. Environmental Protection Agency [EPA] and one approved by EPA) did not comply with the Clean Water Act because they were not expressed as *daily* loads.

This D.C. Circuit precedent does not apply to California, which is subject to the 9th Circuit Court of Appeals.

As a result of the decision, EPA issued a memorandum entitled *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015* (April 25, 2006) and Implications for NPDES Permits in November 2006 that recommends that all TMDLs and associated load allocations (LAs) and wasteload allocations (WLAs) include a daily time increment in conjunction with other temporal expressions (e.g., annual, seasonal) that may be necessary to implement the relevant water quality standards.

Subsequently, in June 2007, the U.S. EPA Office of Wetlands, Oceans & Watersheds issued draft guidance providing calculation methods for "daily load expressions" (USEPA 2007). This draft guidance states the following.

> …In an effort to fully understand the physical and chemical dynamics of a waterbody, many TMDLs are developed using methodologies that result in identified allocations of monthly or greater time periods. EPA encourages TMDL developers to continue to apply accepted and reasonable methodologies when calculating TMDLs for impaired waterbodies and to use the most appropriate averaging period for developing allocations based on factors such as available data, watershed and waterbody characteristics, pollutant loading considerations, applicable standards, and the TMDL development methodology, among other things. For a variety of reasons, EPA recognizes that it might continue to be appropriate and necessary to identify non-daily allocations in TMDL development despite the need to also identify daily loads. For parameters such as sediment, for which narrative water quality criteria often apply, attainment of [*water quality standards*] cannot always be judged on a daily basis. Assessment of cumulative loading impacts is necessary to understand how to achieve [*water quality standards*] and to estimate the allowable loading capacity; therefore identifying long-term allocations for such situations is appropriate and informative from a management perspective. For TMDLs in which it is determined that a non-daily allocation is more meaningful in understanding the pollutant/waterbody dynamics, EPA recommends that practitioners identify and include such an allocation, as well as a daily load expression with the final TMDL submission….

A daily or average daily TMDL is inappropriate for the proposed allocations and TMDLs due to both (1) the temporal component embedded in the applicable water quality standards that the allocations were developed to protect, and (2) the nature of mercury transport and methylmercury production in rivers and reservoirs. The allocations protect wildlife and human health beneficial uses related to consuming watershed and Bay fish. The water quality objectives, which protect these uses, are the narrative bioaccumulation objective, the numeric fish tissue objectives, and the numeric mercury CTR criterion. These objectives reflect environmental exposure over time and therefore it is preferable to assign a concentration limit (rather than a daily or average daily load [i.e., mass per time]) to ensure attainment of these objectives.

In any case, U.S. EPA noted in this guidance document that "for pollutants where the [*water quality standard*] has a longer than daily duration (e.g., monthly or seasonal average), individual values that are greater than the daily expression do not necessarily constitute an exceedance of the applicable standard." This is the case with this TMDL project, which is in response to elevated mercury concentrations in fish tissue, which is accumulated over months to years. We nonetheless provide the following interpretations of our concentration-based allocations and TMDLs as a daily load expression in grams per day (g/d), in accordance with the draft U.S. EPA guidance. However, this is a complex system and these interpretations are based on simplifying assumptions, so we intend to implement the concentration-based TMDLs and allocations (see Table 8.5).

#### *Methylmercury Daily Load Expressions*

The daily methylmercury load expressions are maximum daily net methylmercury production. They are calculated by multiplying the concentration limit by volume and dividing by number of days of methylmercury accumulation. This method maintains consistency with the original approach by recognizing that methylmercury is produced and accumulated in the dry season, and it reflects the critical condition of methylmercury uptake after turnover in the fall, in accordance with the U.S. EPA guidance document (USEPA 2007). The methylmercury concentration limit in reservoirs and lakes is the allocation, a seasonal peak of 1.5 ng/l. The volume is the estimated volume of the hypolimnion. The number of days is the duration of methylmercury production from mid-May to mid-September, approximately 120 days. This results in a maximum daily load (i.e., daily net production) of methylmercury in grams per day, calculated to one significant figure (to maintain consistency with the original approach).

The hypolimnion volume generally decreases over this period because, typically, reservoirs are drawn down during this period. The Santa Clara Valley Water District's (District's) website provides reservoir capacity (design capacity) and percent of capacity (actual volume as a percent of design capacity). In 2007, Guadalupe, Almaden, and Calero reservoirs were filled to about 40 percent of capacity in mid-September (SCVWD ALERT Reservoir Gauge Information, Historic Reservoir Gauge Report, http://alert.valleywater.org/cgi-bin/gageresv). No information is provided about Lake Almaden, probably because it is not a reservoir. We estimate its volume to be one-half that of Almaden Reservoir.

In 2004, Tetra Tech conducted detailed studies of Almaden and Guadalupe reservoirs, including depth profiles. These depth profiles indicate that the hypolimnion extended up to about one-half the depth of the reservoirs (Figure 4-2, Tetra Tech 2005a). Because these reservoirs are located in steep-sided canyons, the volume decreases with depth. Therefore, we estimate that the hypolimnion is about one-third of reservoir and lake volume remaining in mid-September.

The methylmercury daily load expressions are presented in Table 8.2; the allocations and TMDLs remain unchanged and are presented on Table 8.5.

**Table 8.2 Methylmercury Daily Load Expressions**

| Water Body | Capacity (acre-feet) | Hypolimnion Volume (estimated, mid-September, acre-feet) | Daily Load Expressions (g/d) |
|---|---|---|---|
| Guadalupe Reservoir | 3,415 | 451 | 0.01 |
| Almaden Reservoir | 1,586 | 209 | 0.003 |
| Calero Reservoir | 9,934 | 1,311 | 0.02 |
| Lake Almaden | 793 | 105 | 0.002 |

#### *TOTAL MERCURY DAILY LOAD EXPRESSIONS*

The daily total mercury load expressions are maximum daily loads. They are a percentage of the annual loads assigned by the San Francisco Bay mercury TMDL to the Guadalupe River watershed. This method maintains consistency with the original approach, namely loads assigned by Bay mercury TMDL to Guadalupe River watershed, and it reflects the critical condition of large storms with high rainfall intensity, in accordance with the U.S. EPA guidance document (USEPA 2007).

The largest loads of total mercury are transported in large storms with intense rainfall (Whyte & Kirchner 2000). Measurements in this two-month study of discharge from a mercury mine in the San Francisco Bay region during a very wet year included a large storm with intense rainfall, and 40 percent of the load was transported in just over one day (28 hours). Assuming that this Bay region study is applicable to the Guadalupe River watershed, and recognizing that the allocation is for 12 months rather than the 2-month period studied, we assume that up to 20 percent of the total mercury load is transported in the Guadalupe River watershed in one day. Therefore, the total mercury load expressions are 20 percent of the Bay TMDL mass allocations, and are presented in Table 8.3; the allocations and TMDLs remain unchanged and are presented on Table 8.5.

**Table 8.3 Total Mercury Daily Load Expressions**

| Description | Allocation (kg/yr) | Daily Load Expressions (g/d) |
|---|---|---|
| Mining Legacy | 1.7 | 340 |
| Urban Stormwater Runoff | 7.2 | 1,440 |
| Nonurban Stormwater Runoff | 0.5 | 100 |

## *8.7 Water Quality Standards Attainment*

Natural erosion and sediment deposition may eventually wash the mining waste out of the Guadalupe River watershed, or bury it. In the Cache Creek watershed, which contains much less mining waste but extends a longer distance to San Francisco Bay compared to Guadalupe, it is estimated that this natural process will take at least 500 years (Cooke & Morris 2004). Consequently, in the Cache Creek Mercury TMDL, Central Valley Water Board staff proposes extensive implementation actions to stop discharges of mining waste and reduce methylmercury production, hence restoring the watershed in fewer than 500 years.

Similarly, San Francisco Bay Water Board staff proposes in this TMDL project (see Section 9) to require extensive implementation actions to reduce discharges of mining waste and methylmercury production. These actions will restore impaired beneficial uses and attain applicable water quality objectives in a timeframe that is more reasonable and acceptable to the public, dischargers, and, presumably, wildlife.

These mercury TMDLs must comply with the federal Clean Water Act, and result in attainment of the Basin Plan narrative objective for bioaccumulation, the Basin Plan numeric water quality objectives, and the USEPA California Toxics Rule numeric water quality objective. The Clean Water Act requires that a TMDL and associated wasteload and load allocations be set at levels that attain all applicable water quality standards, which include beneficial use protections, narrative water quality objectives, numeric water quality objectives, and anti-degradation policies (Section 6.2). As described in the Introduction (Section 1), to protect beneficial uses, the applicable water quality standards are those related to mercury impairment and include the following:

<u>Mercury Concentration Standards Applicable to the Water Column:</u>

- Basin Plan numeric water quality objective (water column 1-hour average)
- California Toxics Rule (CTR) numeric water quality objective (30-day average)

<u>Mercury Concentration Standards Applicable to Fish Tissue:</u>

- Beneficial uses for human consumption of fish: Water Contact Recreation (REC1)
- Beneficial uses for wildlife consumption of fish: Preservation of Rare and Endangered Species (RARE), and Wildlife Habitat (WILD)
- Basin Plan narrative water quality objective for bioaccumulation
- Basin Plan numeric water quality objectives (proposed wildlife objectives in fish tissue)

First, we evaluate water quality standards attainment for the water column standards. The total mercury TMDLs and wasteload and load allocations proposed in this section are set at levels to attain the Basin Plan and CTR water column standards. (Recall from Section 5 that the Basin Plan 4-day average water column objective is being vacated.) Suspended sediment concentrations (SSC) were measured in the Guadalupe River at Highway 101 during four recent wet seasons, water years 2003 [WY03] through WY06. The maximum 1-hour and 30-day average SSC were 1,153 mg/l in WY03 and 84 mg/l in WY06, respectively (McKee 2007). Multiplying the measured SSC concentration by the higher of the allocations proposed in Section 8, 0.2 mg/kg mercury, and noting that the resulting units are ng/l, both the Basin Plan 1-hour (2,400 ng/l) and CTR 30-day (50 ng/l) water quality standards will be met.

Furthermore, this attainment analysis for the water column standards is conservative for the following reasons. First, it is reasonable to assume that the implementation plan for this TMDL (Section 9), which calls for erosion control at and downstream of mercury mines, will result in lower SSC. Second, the total mercury allocations are set at both 0.1

and 0.2 mg/kg, but we performed the analysis at the higher level of 0.2 mg/kg. Next, we evaluate water quality standards attainment for the fish tissue standards.

The fish tissue targets (see Section 6, Numeric Targets) are set at levels to attain the Basin Plan numeric and narrative standards. The proposed fish methylmercury targets are equal to the proposed wildlife objectives and provide a numeric interpretation of the Basin Plan narrative objective for bioaccumulation, and are protective of wildlife and human health (see Section 5.2). Achieving these targets will attain the REC1, RARE, and WILD beneficial uses, the Basin Plan narrative objective for bioaccumulation, and the proposed wildlife objectives.

In summary, these mercury TMDLs and wasteload and load allocations are set at levels to attain the applicable water quality standards.

### *8.8 Integration with San Francisco Bay Mercury TMDL*

The Guadalupe River watershed mercury TMDL will be the primary regulatory vehicle for achieving water quality goals in the watershed and will simultaneously reduce the load of mercury to the Bay in accordance with the requirements of the San Francisco Bay mercury TMDL (SFBRWQCB 2004 & 2006). In accordance with State Board guidance, the two TMDLs are being carefully integrated in terms of load allocations. The San Francisco Bay mercury TMDL assigns allocations to the Guadalupe River watershed as listed in Table 8.4.

**Table 8.4 Bay Mercury TMDL Allocations to Guadalupe River Watershed**

| Description | Existing Load (kg/yr) | Allocation (kg/yr) | Load Reduction (%) |
|---|---|---|---|
| Mining Legacy | 92 | 1.7 | 98% |
| Urban Stormwater Runoff | 14 | 7.2 | 49% |
| Nonurban Stormwater Runoff | 0.5 | 0.5 | None |
| **Bay TMDL total:** | **106.5** | **9.4** | **- -** |

The two TMDLs are integrated in the following ways:

1) Urban stormwater runoff is assigned the equivalent allocation (7.2 kg/yr in the Bay TMDL, and 0.2 mg/kg in the Guadalupe TMDL, to be achieved within 20 years).
2) Nonurban stormwater runoff in the Bay TMDL is called naturally occurring mercury in soil in the Guadalupe TMDL, and is assigned the equivalent allocation (0.5 kg/yr in the Bay TMDL, and 0.1 mg/kg in the Guadalupe TMDL).
3) There is an extensive transition zone from the Guadalupe River through the tidal Alviso Slough to San Francisco Bay. The two TMDLs will be coordinated to ensure that the fate and transport of mercury-laden sediments from the river will be addressed, particularly in the hundreds of acres of soon-to-be-restored salt ponds adjacent to, and near the mouth of, Guadalupe and Alviso sloughs (South Bay Salt Ponds Restoration Project.)

***Key Points***

**Table 8.5 Allocations**

*Impoundment Methylmercury Allocation*

- 1.5 ng/l seasonal maximum of methylmercury in the hypolimnion of Guadalupe, Almaden, and Calero reservoirs, and Lake Almaden

  *Definition of impoundments:* engineered structures that pond water. They include dams (i.e., reservoirs), former quarries (i.e., lakes and percolation ponds), flood control structures, other engineered features (such as drop structures), and vegetation that ponds water.

*Mining Waste Total Mercury Allocations*

- 0.2 mg mercury per kg mercury mining waste (dry wt., median) in erodible mercury mining waste from the New Almaden Mining District, and Guadalupe, Santa Teresa, and Bernal mercury mines; this allocation shall be measured in fines less than 63 microns in diameter; and
- 0.2 mg mercury per kg erodible sediment (dry wt., median) discharged from depositional areas in creeks that drain mercury mines.

  *Definition of "erodible"*: material readily available for transport by stormwater runoff to surface waters.

*Urban Stormwater Runoff Total Mercury Allocation*

- 0.2 mg/kg mercury (dry weight, annual median) in suspended sediments

*Nonurban Stormwater Runoff Total Mercury Allocation*

- 0.1 mg/kg mercury (dry weight, annual median) in suspended sediments

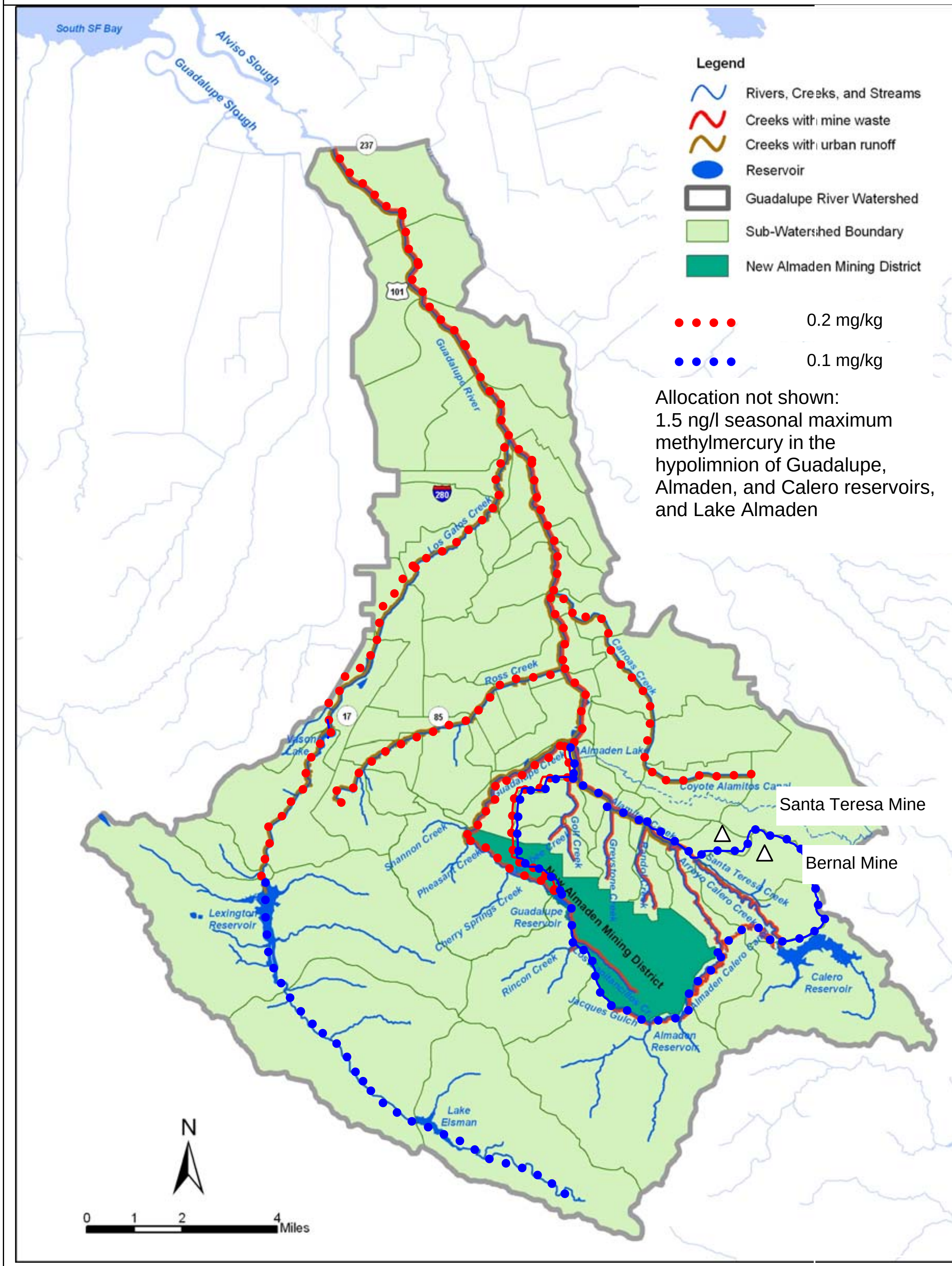
*Atmospheric Deposition Total Mercury Allocation*

- 23.2 micrograms of mercury per square meter per year

## Table 8.6 Waters, Allocations & TMDLs

| Waters | Allocation | TMDL | New Water Quality Objectives Apply | Implementation |
|---|---|---|---|---|
| **Impaired—303(d) listed reservoirs & lakes** Guadalupe, Almaden, and Calero reservoirs, and Lake Almaden | **1.5 ng/l methylmercury** seasonal maximum in hypolimnion | Same as allocation | Yes | See Section 9 |
| **Impaired—303(d) listed creeks & river** Guadalupe and Alamitos creeks, Guadalupe River | **0.2 mg/kg mercury** in erodible sediment (dry weight, median) | **0.2 mg/kg mercury** (annual median, dry weight) in suspended sediments | Yes | See Section 9 |
| **Creeks that drain mercury mines** | **0.2 mg/kg mercury** in erodible sediment (dry weight, median) | No | Yes | See Section 9 for waters that drain mercury mines<br>See San Francisco Bay mercury TMDL for waters that convey urban stormwater runoff |
| **Creeks that convey urban stormwater runoff** | **0.2 mg/kg mercury** (dry weight, annual median) in suspended sediments | No | No | See San Francisco Bay mercury TMDL for waters that convey urban stormwater runoff |
| **Source—non-urban, non-mine mercury source to 303(d) listed waters** i.e., naturally occurring mercury in soil and atmospheric deposition | | | | |
| Waters upstream of Lenihan Dam | **0.1 mg/kg mercury** (annual median, dry weight) in suspended sediments | No | No | No actions required See Section 9 |
| Waters upstream of Guadalupe Reservoir (except tributaries that drain Los Capitancillos Ridge, including but not limited to Los Capitancillos Creek)<br>Waters upstream of Almaden Reservoir (except tributaries that drain Los Capitancillos Ridge, including but not limited to Jacques Gulch)<br>Waters upstream of Calero Reservoir | **0.1 mg/kg mercury** (annual median, dry weight) in suspended sediments | No | Yes | No actions required See Section 9 |

**Figure 8.1 Allocations**



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# 9. Implementation and Monitoring

The goals of this implementation plan for mercury in the Guadalupe River watershed are:

- To restore and protect beneficial uses in waters of the Guadalupe River watershed by reducing mercury loads and methylmercury production
- To restore and protect beneficial uses in San Francisco Bay by reducing legacy and urban stormwater runoff mercury loads

In this section we present our strategy to achieve these goals. Periodically, we will evaluate the effectiveness of this strategy in attaining these goals, and if progress is not proceeding as planned, we will revise our strategy as necessary.

#### *IMPLEMENTATION SEQUENCE*

The TMDLs for mercury in the Guadalupe River watershed will be implemented in two phases, with targets to be achieved in 20 years. A comprehensive review of progress and prospects for achieving the TMDLs will be conducted at the end of the first, 10-year phase.

Goals for the first phase of implementation are:

- Implement effective source control measures for mining waste at mine sites
- Complete studies and designs to cleanup and restore Alamitos Creek
- Complete studies of methylmercury and bioaccumulation controls in reservoirs and lakes and implement effective controls

The goals for the second phase of implementation, which the Water Board also anticipates to extend over 10 years, are to achieve both the fish tissue targets specified in this TMDL project and the legacy and urban stormwater runoff mercury load allocations assigned to the Guadalupe River watershed by the San Francisco Bay mercury TMDL (SFBRWQCB 2006).

Throughout both phases, the Water Board will require responsible parties and permittees to monitor mercury loading, concentrations, and bioaccumulation to ensure that total and methylmercury levels decline adequately. As described in Section 9.9, although responsible parties may conduct the required monitoring individually, the Water Board encourages a coordinated watershed approach to monitoring.

#### ORGANIZATION OF THIS SECTION

This section contains the implementation plan to achieve the goals, describes our regulatory authority to compel actions, specifies implementation actions and parties responsible for these actions, and monitoring and reporting requirements including special studies. The implementation plan and monitoring requirements are presented in the following sections:



## 9.1 Overview of Implementation Actions

In this section we present a brief overview of the implementation actions by source category. Detailed implementation actions are provided below in Sections 9.3–9.6. (These detailed sections are organized by geographic location, from the top to the bottom of the watershed, and focus on the first, 10-year phase of implementation).

This implementation plan builds upon existing efforts that have successfully reduced mercury loads in this watershed (see Cleanup of Almaden Quicksilver County Park; Natural Resources Damages Assessment; and Water District Mitigation, Maintenance, and Restoration Projects, all in Section 3.5). In requiring actions to further reduce mercury, the Water Board relies on its existing authorities and ongoing regulatory programs, such as the Clean Water Act's Section 401/404 certification program, Santa Clara Valley Water District's Stream Maintenance Program, and other mechanisms that will help to achieve the TMDLs in an efficient and cost effective manner (see Section 9.2, Legal Authorities and Requirements.)

A summary of implementation and monitoring requirements is provided on Table 9.1.

**Table 9.1 Summary of Implementation and Monitoring Requirements, Phase 1 (first 10 years)**

| Sources, Goals, and Responsible Parties | Responsible Party Actions | Responsible Party Monitoring Requirements |
|---|---|---|
| **Source: Mercury Mines**<br>Goal: Implement effective source control measures for mining waste at mine sites<br>Responsible parties: previous owners and operators of mercury mines, and current mine property owners | Investigate erosion of mercury mining waste to surface waters within the first two years of Phase 1, but no later than December 31, 2010<br>Develop plans and schedules to control mercury mining waste discharges to surface waters, within 6 months of approval of the investigation report<br>Cleanup and abate discharges of mercury mining waste within the 10-year duration of Phase 1, and no later than December 31, 2018 | 1 [a]) effectiveness of erosion control measures<br>2) mercury loads at discharge points<br>3) fish bioaccumulation of mercury in downstream waters<br>4) mercury loads discharged to San Francisco Bay<br>5) special study 3b<br>Requirements 3), 4), and 5) may be satisfied through a coordinated watershed monitoring program |
| **Source: Reservoirs and Lakes**<br>Goal: Complete studies of methylmercury and bioaccumulation controls and implement effective controls<br>Responsible party: Santa Clara Valley Water District (District) | Continue to operate, maintain and improve the performance of, or replace with newer technology, existing methylmercury controls already in place on Lake Almaden, Almaden Reservoir, and Guadalupe Reservoir | 2[a]) mercury loads at discharge points<br>3) fish bioaccumulation of mercury in downstream waters<br>4) mercury loads discharged to San Francisco Bay<br>5) conduct special studies 1, 2, 3a, & 3b<br>Requirements 3), 4) , and special study 3b may be satisfied through a coordinated watershed monitoring program |

a. Numbering of monitoring requirements corresponds to Monitoring Program (see Section 9.9).

Phase 1 continued on next page

**Table 9.1 Summary of Implementation and Monitoring Requirements, Phase 1 (first 10 years) - continued**

| Sources, Goals, and Responsible Parties | Responsible Party Actions | Responsible Party Monitoring Requirements |
|---|---|---|
| **Source: Depositional Areas**<br>Project Type: Individual projects undertaken voluntarily, such as creekbank stabilization projects<br>Responsible Parties: project applicants | Applicants to comply with conditions in § 401 certifications and/or waste discharge requirements | 1 [a]) effectiveness of erosion control measures |
| Project Type & Goal: Complete studies and designs to cleanup and restore Alamitos Creek, which is highly polluted with mercury mining waste<br>Responsible Parties: District, local agencies, and creekside property owners | District will continue its stream stewardship by completing studies and designs to cleanup and restore Alamitos Creek<br>Creekside property owners along Alamitos creek to provide occasional access to support design studies, and participate in District's public process | Alamitos Creek: no monitoring required during Phase 1 |
| **Source: Urban Stormwater Runoff**<br>Responsible Parties: Permit holders (cities, districts, and county) | The implementation plan for urban stormwater runoff is contained in the San Francisco Bay mercury TMDL. | Permit holders may choose to participate in coordinated watershed monitoring |
| **Source: Nonurban Stormwater Runoff** | No implementation actions are required for nonurban and/or non-mined areas of the watershed. | No monitoring required |
| **Source: Atmospheric Deposition** | The implementation plan for atmospheric deposition is contained in the San Francisco Bay mercury TMDL. | No monitoring required |

a. Numbering of monitoring requirements corresponds to Monitoring Program (see Section 9.9).

**Table 9.1 Summary of Implementation and Monitoring Requirements, Phase 2 (second 10 years)**

| Sources, Goals, and Responsible Parties | Responsible Party Actions | Responsible Party Monitoring Requirements |
|---|---|---|
| **Source: Mercury Mines** | Erosion control to be completed in Phase 1 | Same as Phase 1 |
| **Source: Reservoirs and Lakes** | If necessary, methylmercury controls to be implemented in Calero Reservoir | Same as Phase 1 |
| **Source: Shallow Impoundments**<br>Goal: If reservoir and lake controls do not attain targets downstream, then control methylmercury production and bioaccumulation in shallow impoundments<br>Responsible parties: District and mercury mines responsible parties | Complete study 3a as soon as possible, and no later than December 31, 2023<br>Complete study 3b no later than December 31, 2023 | 5[a]) District to conduct special study 3a, as deemed necessary by the Water Board Executive Officer<br>5[a]) If directed by Water Board, District, mercury mines responsible parties, and urban stormwater runoff permittees to conduct special study 3b |

a. Numbering of monitoring requirements corresponds to Monitoring Program (see Section 9.9).

Phase 2 continued on next page

| Table 9.1 Summary of Implementation and Monitoring Requirements, Phase 2 (second 10 years) -- continued | | |
|---|---|---|
| **Sources, Goals, and Responsible Parties** | **Responsible Party Actions** | **Responsible Party Monitoring Requirements** |
| **Source: Depositional Areas**<br>Project Type: Individual projects undertaken voluntarily, such as creekbank stabilization projects<br>Responsible Parties: Project applicants | Applicants to comply with conditions in § 401 certifications and/or waste discharge requirements | 1 [a]) effectiveness of erosion control measures |
| **Source: Depositional Areas**<br>Project Type & Goal: Cleanup and restore Alamitos Creek<br>Responsible Parties: District, local agencies, and creekside property owners | District and local agencies to complete cleanup and restoration of Alamitos Creek<br>Creekside property owners along Alamitos creek provide the District occasional access for construction and monitoring | 1 [a]) District and local agencies to monitor effectiveness of erosion control measures<br>Creekside property owners provide occasional access for construction and monitoring |
| **Source: Urban Stormwater Runoff**<br>Responsible Parties: Permit holders (cities, districts, and county) | The implementation plan for urban stormwater runoff is contained in the San Francisco Bay mercury TMDL. | Permit holders may choose to participate in coordinated watershed monitoring |
| **Source: Nonurban Stormwater Runoff** | No implementation actions are required for nonurban and/or non-mined areas of the watershed. | No monitoring required |
| **Source: Atmospheric Deposition** | The implementation plan for atmospheric deposition is contained in the San Francisco Bay mercury TMDL. | No monitoring required |
| a. Numbering of monitoring requirements corresponds to Monitoring Program (see Section 9.9). | | |

#### *MERCURY SOURCE CONTROL ACTIONS FOR MINING WASTE*

Actions are required to control mercury mining waste sources. Sections 9.3 and 9.5 specify actions required to reduce discharges of sources of mercury mining wastes to surface waters. In Tables 9.2 and 9.4 we note example implementation measures for mercury mine-related sources. Goals for these actions are as follows:

- In the New Almaden Mining District, and Guadalupe, Santa Teresa, and Bernal mercury mines, the goal is to prevent excessive erosion of mercury mining waste by stabilizing and vegetating slopes. Excessive erosion results from anthropogenic alterations to the land surface that produce, for example, landslides, slumps, gullies, rills, and loss of vegetation. The goal is to restore the landscape by reasonable and feasible means to nearly natural erosion rates. Source control actions for mercury mining waste will be phased so that mercury discharges from upstream mine sites will be eliminated or significantly reduced before downstream projects are undertaken.
- In downstream depositional areas along Guadalupe, Alamitos, Calero and Canoas creeks and downstream reaches of the Guadalupe River, the goal is to prevent further erosion of mercury mining waste and resuspension of mercury-laden sediments accumulated in creek beds, banks, and floodplains, and in shallow impoundments.

The allocations to mercury mining waste and mercury-laden sediment (Section 8.1) are not cleanup standards (see Section 9.2). Implementation actions that reduce loads of mercury from mining waste and/or mercury-laden sediment to the waters of the Guadalupe River watershed downstream of dams will also count towards achieving the San Francisco Bay mercury TMDL allocation to legacy mercury sources in the Guadalupe River watershed.

##### Mercury Mining Waste Responsible Parties

Responsible parties, and their responsibilities under this TMDL project, are defined in CWC § 13304(a) as follows.

> Any person…who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance, shall upon order of the regional board, clean up the waste or abate the effects of the waste, or, in the case of threatened pollution or nuisance, take other necessary remedial action, including, but not limited to, overseeing cleanup and abatement efforts.

Responsible parties include, but are not limited to, current mine site property owners and prior mine owners and/or operators. These parties are responsible for investigation of the erosion potential of mercury mining waste, source control for mercury mining waste with potential to erode into surface waters, monitoring to ensure that erosion controls are effective, and other monitoring (see Section 9.3).

The parties responsible for controlling mercury mining waste discharges from the New Almaden Mining District include, but are not limited to, the following:

- Previous owners and operators of mercury mines, including but not limited to: Myers Industries, Inc., Buckhorn, Inc., Sunoco, Inc., Newson, Inc., E.A. Viner International Co., Inc.
- Current property owners: County of Santa Clara, Midpeninsula Regional Open Space District, and owners of the former Hacienda Furnace Yard site outside of the Almaden Quicksilver County Park boundary

The parties responsible for controlling mercury mining waste discharges from Guadalupe, Santa Teresa, and Bernal mercury mines include, but are not limited to, the following:

- Previous owners and/or operators of mercury mines
- Current property owner of Guadalupe mercury mine: Guadalupe Rubbish and Disposal Company, Inc.
- Current property owners of Santa Teresa mercury mine: (residential landowner)
- Current property owner of Bernal mercury mine: County of Santa Clara

#### *MERCURY SOURCE CONTROL ACTIONS FOR URBAN STORMWATER RUNOFF*

The source control and pollution prevention actions required by the San Francisco Bay mercury TMDL for the urban stormwater runoff source are anticipated to be sufficient to attain the allocation for discharges to waters of the Guadalupe River watershed. Therefore, we do not propose additional implementation actions for this source for the first, 10-year phase of Guadalupe implementation. At the completion of this first phase, we will evaluate whether additional implementation actions will be needed for the second, 10-year phase of implementation. Urban stormwater runoff implementation actions in the Guadalupe River watershed that reduce loads of mercury to San Francisco Bay will also count towards achieving the Guadalupe River watershed mercury TMDL allocation to the urban stormwater runoff source.

##### Urban Stormwater Runoff Responsible Parties

Urban stormwater runoff is subject to NPDES permits. These NPDES permits are reissued every five years. The dischargers regulated under NPDES permit no. CAS029718, the permit in effect in September 2008, are the following: Santa Clara Valley Water District, County of Santa Clara, Town of Los Gatos, cities of Campbell, Monte Sereno, San José, Santa Clara, and Saratoga.

#### *NO ACTIONS PROPOSED FOR NONURBAN STORMWATER RUNOFF AND ATMOSPHERIC DEPOSITION*

Parallel with the Bay mercury TMDL, the Guadalupe load allocations to nonurban stormwater runoff and atmospheric deposition are their current loads. No implementation actions are proposed for these two sources, for the reasons provided below.

No implementation actions are proposed for the nonurban stormwater runoff source because no waters in the Guadalupe River watershed are listed for impairment by sediment. Also, natural rates of erosion of this low-mercury sediment are desirable, as this will provide clean sediment to the bottom of reservoirs, lakes, and depositional areas, thus capping sediments containing mining waste. Bottom sediment mercury concentrations are closely linked to fish mercury concentrations (see Section 7, Linkage).

As discussed in Section 8.5, no reductions are called for in the nonurban stormwater runoff source. Vegetating exposed mining waste as part of mine site erosion control actions will reduce atmospheric inputs from local sources. In the Bay mercury TMDL, we acknowledged the predominant role of global (non-local) sources, and our limited authority in this international arena. Nonetheless, we called for the U.S. EPA to actively pursue international efforts to address this issue, and for the Bay Area Air Quality Management District to conduct a local mercury emissions inventory. These actions are not only sufficient to address this source, but they are better undertaken at these larger regional, national, and international scales. Therefore, no implementation actions are required for atmospheric deposition.

#### *METHYLMERCURY PRODUCTION CONTROL ACTIONS*

The Santa Clara Valley Water District is a leading researcher in methods of controlling methylmercury production and bioaccumulation. This TMDL project anticipates that before the end of the implementation period, new methylmercury production controls in reservoirs and lakes will reduce methylmercury bioaccumulation both in the reservoirs and lakes, and downstream. However, if implementation actions in the reservoirs and lakes do not result in attaining targets downstream, the Water Board will require evaluation of methods to control methylmercury production and bioaccumulation in shallow impoundments. In Table 9.3 we note example implementation actions for reservoirs and Lake Almaden. Goals for these actions are:

- In the Guadalupe, Almaden, and Calero reservoirs and Lake Almaden, the goal is to reduce production of methylmercury and bioaccumulation. As explained in the linkage discussion (Section 7), mercury methylates in the cold, anoxic waters of these deep impoundments. Methylmercury is then discharged downstream in reservoir and lake releases. Reducing methylmercury production in, and methylmercury releases from, these deep impoundments should also reduce methylmercury levels in downstream waters (see Table 9.3.)

#### Methylmercury Responsible Parties

The party responsible for controlling methylmercury production in and releases from reservoirs and lakes is the Santa Clara Valley Water District. The parties responsible for controlling methylmercury production in, and releases from, shallow impoundments include, but are not limited to, mercury mine responsible parties and the Santa Clara Valley Water District. Potential additional responsible parties may include urban stormwater runoff permittees that discharge excess nutrients and contribute to methylation of mercury (see Section 9.7, *Excess Nutrients from Controllable Sources*).

## *9.2 Legal Authorities and Requirements*

California law and the federal Clean Water Act give the Water Board responsibility and broad authority for regional water quality control and planning. Under the Porter-Cologne Water Quality Control Act (California Water Code, Division 7; referred to as the Water Code or CWC), the Water Board issues requirements for submission of technical or monitoring program reports (Water Code § 13267), compels cleanup of waste discharges (Water Code § 13304), and issues general or individual waste discharge permits (Water Code § 13260 et seq.). The Water Board must also follow California Code of Regulations § 22470 et seq., which specifies mine closure performance standards as follows:

"new and existing mining units shall be closed so that they no longer pose a threat to water quality."

The Basin Plan, in Section 4 (Implementation Plan), contains a plan to address the water quality problems associated with mines (Section 4.21.4). We have developed Section 9.3 herein to be consistent with the Basin Plan requirements for inactive mine sites.

Additionally, the Water Board has authority under the Clean Water Act (CWA) to issue NPDES stormwater permits for point sources of contamination. Stormwater discharges that contribute to a violation of a water quality standard or are a significant contributor of pollutants to waters of the United States require NPDES stormwater permits in accordance with CWA § 402(p)(2)(E).

Under the Clean Water Act's Section 401, every applicant for a federal permit or license for any activity that may result in a discharge to navigable waters must obtain certification from the state that the proposed activity will comply with the Clean Water Act and state requirements to protect water quality.

#### Mining Waste Allocations Are Not Cleanup Standards

As stated at the beginning of Section 8.1, the goal for the mining waste allocations is to eliminate inputs of mercury from legacy mining operations to surface waters. It is important to note that the fish tissue numeric targets, TMDLs, and the TMDL allocations are not directly enforceable. Further, the allocations to mercury mining waste and mercury-laden sediment (Section 8.1) are neither cleanup standards nor water quality certification performance conditions. However, the Water Board may (a) specify conditions in water quality certifications (if applicable), and (b) establish cleanup standards in waste discharge requirements (WDRs), in cleanup and abatement orders (CAOs), or in other Water Board orders. We present some ideas on how to calculate cleanup standards, such as pre-mining ambient soil mercury concentrations, in Section 9.10.

If necessary and appropriate, cleanup standards will be included in Water Board orders. However, cleanup standards are not required for many erosion control best management practices, as described in *Attainment of Mining Waste Allocations*, presented below.

#### Attainment of Mining Waste Allocations

Water Board staff proposes to evaluate attainment of the mining waste allocations through Water Board oversight of selection, design, construction, and operations and maintenance of best management practices for erosion control. This is the same evaluation method as proposed for the inactive mercury mines in the Cache Creek watershed, for which mercury loads must be reduced by 95 percent (CVRWQCB 2005). Similarly, in the Tomales Bay Pathogens TMDL, to demonstrate attainment of applicable allocations, responsible parties are responsible for compliance with specified best management practices and applicable waste discharge requirements or waiver conditions. In many cases, we plan to rely on visual inspections to confirm that erosion control measures are performing as designed, see Section 9.9, *Effectiveness of Mining Waste Control Measures*, *Landscape Erosion Control Monitoring*.

### 9.3 Implementation Actions for Mercury Mines

The goal for mercury mines is to restore the landscape to nearly natural erosion rates by reasonable and feasible means. Mercury mining has altered the land surface and caused excessive erosion from, for example, landslides, slumps, gullies, rills, and loss of vegetation. Some areas of unstable mining waste may require geotechnical stability studies and application of site-specific restoration and construction methods. However, we believe that most areas of mining waste will be successfully addressed by best management practices for erosion control, such as vegetation and run-on controls.

Load allocations for mercury mining waste discharged from the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines will be implemented through Water Code §§ 13267 and 13304 orders to compel investigation, clean up and monitoring, as well as through Basin Plan Section 4.21.4 to the extent applicable. Responsible parties are described in Section 9.1. As previously stated, this allocation to mercury mining waste is not a cleanup standard (see Section 9.2).

Previously completed and currently underway mercury cleanup project sites in Almaden Quicksilver County Park will be excluded from Water Code §§ 13267 and 13304 orders pertaining to investigation and cleanup. However, these cleanup sites will remain subject to the Industrial Stormwater General NPDES Permit requirements for maintenance and monitoring. Previously completed mercury cleanup projects at Hacienda Furnace Yard (including immediately adjacent reaches in Alamitos Creek and Deep Gulch); Mine Hill; San Francisco Open Cut; Senador, Enriquita, and San Mateo mines will be excluded from Water Code §§ 13267 and 13304 orders. This exclusion is limited to the footprints of the projects as provided in the completion reports (CH2MHill 1998 & 1999). Also excluded from Water Code §§ 13267 and 13304 orders are mercury cleanup projects currently underway in Alamitos Creek and Deep Gulch immediately adjacent to the Hacienda Furnace Yard; and in Jacques Gulch. This exclusion is limited to the as-constructed footprints of the projects, as described in the completion report for the project. The proposed footprints are described in documents pertaining to the settlement of the NRDA claim brought by U.S. FWS (see Section 3.5; DFG 2005).

A goal of these orders and requirements is to compel responsible parties to control erosion of mercury mining waste by stabilizing and vegetating slopes. Table 9.2 provides example implementation measures to achieve this goal. The Water Board will issue the § 13267 orders by June 30, 2009, and the § 13304 orders by June 30, 2011 (see Tables 9.2 and 9.5.)

#### IMPLEMENTATION ACTIONS THAT REDUCE LOADS OF MERCURY FROM MINING WASTE AND/OR MERCURY-LADEN SEDIMENT TO THE WATERS OF THE GUADALUPE RIVER WATERSHED DOWNSTREAM OF DAMS WILL ALSO COUNT TOWARDS ACHIEVING THE SAN FRANCISCO BAY MERCURY TMDL ALLOCATION TO LEGACY MERCURY SOURCES IN THE GUADALUPE RIVER WATERSHED. REQUIRED MONITORING

Additionally, the orders will require the responsible parties to conduct monitoring beginning with the 2009-2010 wet season (if they are not already monitoring). The monitoring will be required to address the following: (1) evaluate the effectiveness of erosion control measures, (2) determine the loads of mercury discharged annually to surface waters at the points of discharge, (3) determine fish bioaccumulation of mercury in waters downstream of the discharge, (4) determine the loads of mercury discharged annually to San Francisco Bay, and (5) answer the questions posed by special study 3b.

(See Section 9.9 for the details of monitoring requirements 1–4, and Section 9.10 for special studies.)

Alternatively, the responsible parties may participate in the coordinated watershed monitoring program (see Section 9.9) to address monitoring requirements 3–5, above. The Water Board may consider waiving or reducing monitoring requirement (2), on an individual basis, based on progress on abating discharges of mining waste and participation in an approved coordinated watershed monitoring program. The responsible parties will be required to submit a (individual or coordinated watershed) monitoring plan for review and approval by the Water Board Executive Officer prior to the 2009-2010 wet season, by October 15, 2009.

**Table 9.2 Implementation Actions for the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines**

| Example Implementation Measures to Control Erosion and Stablize Mining Waste | Site Assessment, Implementation, and Reporting Requirements | Completion Dates |
|---|---|---|
| Conduct a site investigation evaluating the erosion potential of mercury mining waste, and the potential for seeps to exacerbate discharges of mercury mining waste to surface waters.<br>Characterize, excavate, stockpile, haul, and consolidate mercury mining waste in engineered, onsite capped/covered waste management units<br>Cleanup and abate discharges from mercury mines and seeps.<br>Construct surface water diversion channels and sub-drains to route clean surface water runoff away from mercury mining waste<br>Re-contour and terrace steep or exposed slopes at mercury mining waste sites to reduce and control surface erosion and eliminate the potential for mass wasting and slope failure<br>Plant exposed soils with grass and native vegetation to minimize sheet-flow erosion of mercury mining waste<br>Construct and maintain stormwater retention basins, detention basins, swales, or other engineered features designed to slow surface runoff, reduce surface erosion, and eliminate sediment transport of mercury mining waste to surface waters.<br>Inventory former mine roads, assess their condition, and implement best management practices to control erosion from roads | Conduct a site investigation evaluating the erosion potential of mercury mining waste, and the potential for seeps to discharge mercury to surface waters.<br>Submit site investigation report for review and approval by the Executive Officer. | Within the first two years of Phase 1, and no later than December 31, 2010 |
| | Develop plans and schedules to control discharges to surface waters.<br>Submit plans and schedules for review and approval by the Executive Officer. | Within 6 months of Water Board approval of investigation report |
| | Following cleanup and abatement of discharges from mercury mines and seeps, submit a cleanup report for review and approval by the Executive Officer. | Within the 10-year duration of Phase 1, and no later than December 31, 2018 |

### 9.4 Implementation Actions for Reservoirs and Lakes

Implementation actions are required to attain the targets in the following deep impoundments: Guadalupe Reservoir, Almaden Reservoir, Lake Almaden, and Calero Reservoir. The Santa Clara Valley Water District (District) is the responsible party for the implementation actions in deep impoundments. The Water Board recognizes the difficulty of attaining targets because attainment may require development and deployment of new and innovative control methods. Nonetheless, this plan calls for implementation to be completed within the 10-year duration of Phase 1 of implementation. We believe this timeline is reasonable based on ongoing studies of new methylation controls. Table 9.3 provides the sequence of studies and implementation measures to attain the targets.

#### STATUS OF TECHNICAL STUDIES

The District already has studies underway of methods to reduce methylmercury production in reservoirs and Lake Almaden, and other methods that have the potential to reduce bioaccumulation of mercury. District staff described their technical studies in a 2005 Staff Report to their Board, as follows (SCVWD 2005):

> Aeration and oxygenation of reservoirs is a proven technology to reduce algae production, promote aerobic digestion of organic detritus, and improve habitat for fisheries (primarily by making more oxygen available by reducing biological oxygen demand).…The technology may also interrupt the biologically-mediated methylation of mercury, resulting in less mercury bio-concentrated in the food web.…
>
> This is the first phase of a three-phase project to evaluate the feasibility of this technology, pilot test a recommended system, and design and install systems in three District reservoirs (Almaden, Calero, and Guadalupe).…The first phase (the subject of this agenda item) will develop and implement a sampling program to characterize the water quality in the three reservoirs from March through November, develop recommendations regarding the feasibility of aeration/oxygenation to improve water quality in each reservoir, and design a recommended system for one of the reservoirs for the purpose of pilot testing.
>
> The second phase (subject to Board approval and assuming the recommendation from the first phase is positive) will be the acquisition and installation of the pilot system, operation and monitoring performance of the system in one reservoir over a period from March through November, and design of recommended systems for the remaining two reservoirs.
>
> The third phase (subject to Board approval) would be preparation of environmental documents, acquisition, installation and startup of systems in all three reservoirs, and operation and maintenance for up to two years to transition over to District staff. However, if the second phase requires environmental documentation, this will be expanded to include all three reservoirs, to save costs and time in implementing the third phase (again, subject to the findings of the first phase and Board approval).…

> The District's Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) Settlement process, the District's Guadalupe River watershed mercury study, and ongoing algae production and taste and odor issues in drinking water treatment plant source water have provided the impetus to explore this technology as a potential means to meet multiple objectives, and the opportunity to cost share this project. Specifically, the FAHCE agreement requires the District to conduct feasibility studies of aeration on Almaden and Guadalupe reservoirs (the former to reduce methylmercury production, and the latter to improve fisheries habitat downstream). Recurring taste and odor issues due to algae production in San Luis and Calero reservoirs may be significantly increasing treatment costs and/or reducing the effective availability of supply, and aeration/oxygenation may be a cost-effective solution for this issue.…

The Water District's studies have proceeded, and expanded from one solar-powered circulator in Lake Almaden in 2006, to, in 2007, two circulators in Lake Almaden, and three circulators in each of Almaden and Guadalupe reservoirs. Recently (Fall 2007), District staff presented a paper entitiled "Reduction of methyl mercury concentrations in an urban lake using a solar-powered circulator" at the North American Lake Management Society meeting. The abstract indicates that experiments show considerable success in reducing methylmercury concentrations (Drury 2007).

> Lake Almaden is the centerpiece of a suburban recreational park in San Jose, CA. It was created by gravel extraction operations in the 1950s and 1960s and is impacted by legacy mercury mining activities conducted nearby between 1850 through 1972. Monitoring data collected in 2005 showed a seasonal production of unfiltered methyl mercury (the form of mercury that is biologically available) strongly correlated with lake stratification and anoxia in the hypolimnion. In 2006, a solar-powered circulator was deployed in one portion of the lake just after stratification had occurred to improve the transfer of oxygen from the surface to the hypolimnion. Because of the unique bathymetry of the lake, the effects of the circulator were localized to one portion of the lake, allowing for comparisons of seasonal production of unfiltered methyl mercury both spatially and temporally.
>
> In 2006, unfiltered methyl mercury concentrations in the treated portion of the lake were reduced by over 96 percent from 2005, which is attributed to improved Oxidation Reduction Potential conditions in the water column created by the circulator. In comparison, unfiltered methyl mercury concentrations in the untreated portion of the lake were slightly higher in 2006 than in 2005. In 2007, a second circulator was deployed in the untreated area, and data from 2007 will be included in the presentation.

#### TECHNICAL STUDY REQUIREMENTS

The District is voluntarily conducting technical studies of methylmercury production and control. As necessary, the Water Board will compel the District to undertake technical studies of methylmercury production, bioaccumulation, and effective control measures for reservoirs and lakes; and studies to evaluate whether such actions are sufficient to attain targets downstream, through Water Code § 13267 requirements.

The District will be required to demonstrate progress in methylmercury controls by reporting to the Water Board by December 31 of odd years (beginning in 2009 until directed by the Water Board to stop) on the technical studies and operation and effectiveness of the methylmercury controls. (The Water Board will consider the need to control methylmercury production and bioaccumulation in shallow impoundments in the reviews described below under "Adaptive Implementation.")

#### *Methylmercury and Bioaccumulation Controls Required*

Load allocations will be implemented according to CWC authorities where the Executive Officer of the Water Board finds it is feasible to reduce methylmercury production and/or bioaccumulation. The Water Board will issue cleanup and abatement orders to the District to undertake actions to reduce fish mercury concentrations to attain the targets. These orders will require the District to develop plans and schedules to implement all reasonable and feasible control actions.

#### *Required Monitoring*

The District will also be required to conduct monitoring. The monitoring plan will be required to address the following: a) determine the loads of mercury discharged annually to surface waters at the points of discharge, b) determine fish bioaccumulation of mercury in reservoirs, lakes, and waters downstream of the discharges, c) determine the loads of mercury discharged annually to San Francisco Bay, and d) answer the questions posed by special studies 1, 2, 3a, and 3b (see Section 9.9 for the details of monitoring requirements, and Section 9.10 for special studies.)

The Water Board encourages the District to lead a coordinated watershed approach to monitoring, particularly for mercury in fish tissue and loads to San Francisco Bay (see Section 9.9.) The Water Board may consider waiving or reducing monitoring requirement a, based on participation in the approved coordinated watershed monitoring program. As necessary, the Water Board will compel the District to undertake monitoring and special studies through CWC § 13267 requirements.

**Table 9.3 Implementation Actions for Reservoirs and Lakes**

| Measures to Reduce Methylmercury Production and Bioaccumulation in Reservoirs and Lakes | Data Gathering, Implementation, and Reporting Requirements | Completion Dates |
|---|---|---|
| Develop effective methylmercury control methods for reservoirs and lakes (underway at time of Basin Plan amendment adoption)<br>Implement methylmercury production and bioaccumulation controls in reservoirs and lakes | Conduct technical studies of hypolimnion methylmercury controls, and other reservoir and lake management techniques that have the potential to reduce bioaccumulation of methylmercury.<br>Submit report of technical studies and control actions implemented for review and approval by the Executive Officer of the Water Board. | Report by December 31 of odd years beginning in 2009 |
| | Continue to operate, maintain, and improve the performance of, or replace with newer technology, existing methylmercury controls already in place on Lake Almaden, Almaden Reservoir, and Guadalupe Reservoir | On-going |
| | If necessary, install methylmercury controls in Calero Reservoir. | No later than December 31, 2017 |
| | | |
| | | |
| | Submit a report of achievement of downstream targets, for review and approval by the Executive Officer of the Water Board | As early as December 31, 2016, but no later than December 31, 2023 |

## *9.5 Implementation Actions for Depositional Areas*

The goal for depositional areas is to restore the creek banks, beds, and floodplains to a stable configuration that minimizes excessive erosion or deposition of mercury mining waste and/or mercury-laden sediment, and avoids adverse effects on beneficial uses. Large amounts of mercury mining waste discharges have altered the configuration of creeks downstream of mercury mines. Particularly in Alamitos Creek downstream of Hacienda Furnace Yard, there are many areas of unstable and actively eroding accumulations of mercury mining waste.

Load allocations to creek beds, banks, and floodplains will be implemented according to both Clean Water Act and California Water Code authorities. We do not propose to compel cleanup of depositional areas, but rather to address these projects upon receipt of applications for CWA Section 401 certifications. The Water Board will issue CWA Section 401 certifications and/or waste discharge requirements to minimize discharge of mercury mining waste (in the form of mercury-laden sediment). Examples of projects subject to these requirements include riparian habitat restoration and creek bank stability projects by the Santa Clara Valley Water District ("the District") and creekside property owners.

Implementation actions that reduce loads of mercury from mining waste <u>and/or mercury-laden sediment</u> to the waters of the Guadalupe River watershed downstream of dams will also count towards achieving the San Francisco Bay mercury TMDL allocation to legacy mercury sources in the Guadalupe River watershed.

#### *GENERAL REQUIREMENTS FOR DEPOSITIONAL AREAS*

The following requirements will apply to projects proposed in depositional areas in creeks and the Guadalupe River downstream of mercury mines or that convey urban stormwater runoff that may result in sediment discharges and/or require CWA Section 401 certifications. Applicants for these projects will be required to:

- Investigate the extent of mercury-contaminated sediments
- Evaluate the erosion potential of these sediments
- Design the project to minimize discharge of mercury-laden sediment
- Monitor channel form and erosion control effectiveness

These projects will be required to be designed for channel stability, and to implement measures during construction to minimize erosion, i.e., the same measures required for all projects requiring CWA Section 401 certifications. Additionally, monitoring and reporting will be required to demonstrate the effectiveness—over time—of the design in attaining a stable channel form, and of effective erosion control, in floodplains, creek banks, and creek beds.

The District may also propose projects in shallow impoundments, which will be regulated through the existing CWA Section 401 certifications and waste discharge requirements for the District's Stream Maintenance Program. The Water Board will issue CWA Section 401 certifications and/or waste discharge requirements to the District for percolation pond operations and maintenance activities unless actions are satisfactorily undertaken on a voluntary basis.

#### *ALAMITOS CREEK: MERCURY CLEANUP, CREEK BANK STABILITY, AND HABITAT RESTORATION*

Although we are not compelling cleanup actions, we strongly encourage cleanup and restoration of Alamitos Creek. About 75 percent of all ore from the principal New Almaden mines was processed at the Hacienda Furnace Yard (Cox 2000) which is located on Alamitos Creek (downstream of Almaden Reservoir). Consequently, we estimate that Hacienda Furnace Yard is the single largest mercury ore processing facility in North America. Alamitos Creek is highly polluted by mining waste because common mining practice at the time included disposing of mining wastes in streams (see Section 3.4). Our strategy is to encourage this project to proceed on a voluntary basis. However, if progress appears to be slower than needed to complete permitting and designs in Phase 1 and construction in Phase 2, the Water Board may consider compelling responsible parties to undertake this project.

Recognizing the District's watershed stewardship mission, and that Alamitos Creek is highly polluted with mercury mining waste, the Water Board encourages a cooperative effort among the District, local agencies, and creekside property owners to undertake a comprehensive mercury cleanup, creek bank stability, and habitat restoration project. Water Code Chapter 5.7 contains a program for public agencies and cooperating private parties, who are not otherwise legally responsible for abandoned mine lands, to reduce the threat to water quality caused by these lands without becoming responsible for completely remediating mining waste from abandoned mines. The Water Board encourages these parties to participate in the program.

This project will reduce discharges of mining waste to Lake Almaden and Guadalupe River, and thereby reduce the District's future expenses for methylmercury controls in Lake Almaden, and disposal of mercury-laden sediment removed for flood control and other stream maintenance program purposes.

The Water Board encourages the District to be the technical lead for this project, and to seek funding for it. The Water Board will identify mercury cleanup as a grant funding priority for the San Francisco Bay region. Where necessary, the Water Board will invoke its cleanup authority to compel upstream dischargers who initially discharged mercury mining waste into depositional areas, to cleanup and abate mercury mining waste.

Responsibilities of creekside property owners include (a) providing reasonable access to the creek for project studies, construction, and monitoring, and (b) not taking actions on their property that worsen the discharge of mercury mining waste into the creek.

Suggested actions and a schedule are provided in Table 9.4 for the mercury mining waste component of this important project.

**Table 9.4 Suggested Implementation Actions for Alamitos Creek**

| Example Implementation Measures to Prevent Erosion and Resuspension of Mercury-laden Sediments | Site Assessment, Implementation, and Reporting Actions | Suggested Timeframe |
|---|---|---|
| Implement bank stabilization measures, such as channel-bank recontouring, planting riparian vegetation, installation of revetment materials<br>Remove mining wastes from creeks and rivers, transport, and dispose at an appropriate disposal facility<br>Reduce flow velocity by constructing detention basins or other features to reduce the erosive force of flow in creek channels. | Conduct a site investigation evaluating the erosion potential of mercury mining waste accumulated in creek beds, banks, and floodplains, and in shallow impoundments.<br>Submit site investigation report for review and approval by the Executive Officer of the Water Board. | By end of year 8 of Phase 1, and no later than December 31, 2016 |
| | Develop plans and schedules to control discharges to surface waters.<br>Submit plans and schedules for review and approval by the Executive Officer. | By end of Phase 1, and no later than December 31, 2018 |
| | Cleanup and abate discharges of mercury mining waste from creek beds, banks, and floodplains, and in shallow impoundments, to surface waters. | No later than December 31, 2028 |
| | Submit a cleanup report for review and approval by the Executive Officer. | No later than December 31, 2028 |

### 9.6 Implementation Actions for Urban Stormwater Runoff

The source control and pollution prevention actions required by the San Francisco Bay mercury TMDL for the urban stormwater runoff source are anticipated to be sufficient to attain the allocation for discharges to waters of the Guadalupe River watershed. Therefore, at this time no additional implementation actions are required by this TMDL project. Urban stormwater runoff implementation actions in the Guadalupe River watershed that reduce loads of mercury to San Francisco Bay will also count towards achieving the Guadalupe River watershed mercury TMDL allocation to the urban stormwater runoff source.

Wasteload allocations will be implemented through the NPDES stormwater permits issued to urban runoff management agencies and the California Department of Transportation (Caltrans). The urban stormwater runoff allocations implicitly include all current and future permitted discharges, not otherwise addressed by another allocation, and unpermitted discharges within the geographic boundaries of urban runoff management agencies (collectively, "source category") including, but not limited to, Caltrans roadway and non-roadway facilities and rights-of-way, atmospheric deposition, public facilities, properties proximate to stream banks, industrial facilities, and construction sites.

The Bay mercury TMDL relies on 1) source control, 2) pollution prevention, 3) stormwater treatment, and/or 4) sediment removal for urban stormwater runoff to attain a suspended sediment concentration of 0.2 mg/kg as it is discharged into San Francisco Bay. (This suspended sediment concentration is equal to the allocation assigned by the Guadalupe River watershed mercury TMDL project.) Source control and pollution prevention actions prevent contamination of stormwater before it is discharged. Treatment would likely route this flow from the collection system to nearby municipal wastewater treatment facilities, which do not discharge into waters of the Guadalupe River watershed. Hence, three of four actions required by the Bay mercury TMDL would result in the mercury concentration in urban stormwater runoff being equal at the point of discharge to waters of the Guadalupe River watershed and at the point of discharge to the Bay. Therefore, we do not propose additional implementation actions for this source for the first 10-year phase of Guadalupe implementation.

The comprehensive review of progress and prospects for achieving the TMDLs will specifically address whether the source control actions required by the Bay mercury TMDL are, indeed, likely to attain the allocation for discharges to waters of the Guadalupe River watershed within the second 10-year phase. This review will be conducted at the end of the first 10-year phase (see 9.7 Adaptive Implementation).

The San Francisco Bay mercury TMDL also proposes the following monitoring and reporting for the urban stormwater runoff NPDES permit requirements:

- Evaluate and report on the spatial extent, magnitude, and cause of contamination for locations where elevated mercury concentrations exist. …
- Develop and implement a monitoring system to quantify either mercury loads or the loads reduced through treatment, source control, and other management efforts. …

- Prepare an annual report that documents compliance with the above requirements and documents either mercury loads discharged or loads reduced through ongoing pollution prevention and control activities.
- Demonstrate compliance with the allocations … using one of the following methods:
  - … Quantify the mercury load as a rolling five-year annual average mercury load using data on flow and water column mercury concentrations.
  - Quantitatively demonstrate that the mercury concentration of suspended sediment that best represents sediment discharged from program areas is below the suspended sediment target.

The above monitoring requirements ("the spatial extent … elevated mercury concentrations;" and either "quantify the mercury load … flow and water column mercury concentrations," or "quantitatively demonstrate that the mercury concentration of suspended sediment … is below the suspended sediment target;") and annual reporting requirements are sufficient for the first 10-year implementation phase of the Guadalupe River watershed mercury TMDLs. These efforts may best be accomplished through a coordinated watershed monitoring effort (see Section 9.9).

The comprehensive review of progress and prospects for achieving the TMDLs described in Section 9.7 will specifically address whether the above monitoring and reporting requirements, which focus on discharges to the Bay rather than to waters of the Guadalupe River watershed, are sufficient for the second 10-year phase. Additionally, if targets are not attained downstream of reservoirs and lakes by actions (by the Santa Clara Valley Water District) implemented during Phase 1, the comprehensive review will investigate other factors contributing to the mercury problem. As discussed in Section 9.7, nutrients may be a factor that contributes to methylation of mercury. Urban stormwater runoff is one of several sources of nutrients. Consequently, in Phase 2, urban stormwater runoff permittees may be required to participate in special study 3b, which is related to nutrients and mercury methylation (see Section 9.10.)

### 9.7 Adaptive Implementation

Adaptive implementation entails applying the scientific method to the TMDL. A National Research Council review of U.S. EPA's TMDL program strongly suggests that the key to improving the application of science in the TMDL program is to apply the scientific method to TMDL implementation (NRC 2001). For a TMDL, applying the scientific method involves taking immediate actions commensurate with available information, defining and implementing a program for refining the information on which the immediate actions are based, and modifying actions as necessary based on new information. This approach allows the watershed to make progress toward attaining water quality standards while regulators and stakeholders improve our understanding of the system through research and by observing how it responds to the immediate actions. Accordingly, these TMDLs will be implemented in phases starting with source controls at mine sites so that upstream mercury discharges will be eliminated or significantly reduced before downstream projects are undertaken.

The adaptive implementation plan for the Guadalupe River watershed mercury TMDLs project includes the following features:

1. Immediate actions commensurate with available data and information. These are described above for each source category.
2. Monitoring to assess effectiveness of immediate actions and progress toward TMDL targets.
3. Statement of management questions, associated scientific hypotheses, and a framework and schedule for addressing the management questions.
4. A process for reviewing and incorporating into the TMDL project information obtained through the studies and monitoring.

The Water Board will adapt these TMDLs, associated allocations, and the implementation plan to incorporate new and relevant scientific information, so that effective and efficient measures can be taken to achieve the targets. We recognize that attaining the methylmercury allocation may be especially difficult because of the need for new and innovative control methods.

The Water Board staff will present an annual progress report to the Water Board on implementation of the TMDL that includes evaluation of new and relevant information that becomes available through implementation actions, monitoring, special studies, and current scientific literature. The annual report will include an accounting of implementation actions undertaken and estimates of (a) mercury permanently removed from the watershed, (b) mercury loads avoided by pollution prevention or erosion control, and (c) methylmercury not produced, and/or other relevant metrics.

We will note in the annual progress report actions by any party that have made it easier for that entity or others to achieve the TMDL project goals. We will report on the District’s progress in developing and testing methylmercury controls (e.g., trends in peak methylmercury concentrations), as that information becomes available. Lastly, we will report on effectiveness of this TMDL project as measured by trends in fish tissue mercury concentrations (i.e., progress in attaining targets) and other relevant metrics (i.e., attaining legacy mercury allocation assigned by the Bay mercury TMDL).

Additionally, staff will evaluate whether the regulatory approach described in this section is effective and still appropriate. For mercury mines, we will evaluate progress in controlling erosion of mercury mining waste. If progress appears to be slower than needed to complete these actions within the ten-year duration of Phase 1, we may consider enforcement and/or reconsider our regulatory approach. For an example of the latter, we may pursue individual or general mercury mines NPDES permits in accordance with the *Mines and Mineral Producers* implementation plan in Chapter 4 of the Basin Plan. For downstream depositional areas, we will evaluate progress made during Phase 1 in developing designs for a comprehensive creek bank stability and habitat restoration project on Alamitos Creek. Our strategy is to encourage this project to proceed on a voluntary basis. However, if progress appears to be slower than needed to complete these designs within the ten-year duration of Phase 1, we may consider compelling responsible parties to undertake this project.

The Water Board, within ten years of the effective date of the TMDL, will evaluate new and relevant information from monitoring, special studies, and scientific literature. Any necessary modifications to the targets, allocations, or implementation plan will be incorporated into the Basin Plan. The Water Board will make new information available to the public and will allow opportunities for public participation regarding the results of the periodic review of the TMDLs and then current progress towards attainment of targets. At a minimum, the following focusing questions will be used to adapt the TMDL.

- Is the watershed progressing toward TMDL targets as expected? If progress is unclear, how should monitoring efforts be modified to detect trends? If there has not been adequate progress, how should the implementation actions or allocations be modified?
- What are the pollutant loads for the various sources? Have these loads changed over time? How do they vary seasonally? How might source control measures be modified to further reduce loads?
- Does additional sediment, water column, or fish tissue total or methylmercury data support our understanding of linkages and food webs in the watershed or suggest an alternative allocation or implementation strategy?
- Can the assimilative capacity of deep impoundments be increased? If so, how can deep impoundments be managed to reduce bioaccumulation?
- Is there new, reliable, and widely accepted scientific information that suggests modifications to targets, allocations, or implementation actions? If so, how should the TMDLs be modified?

Additional focusing questions will be developed in collaboration with stakeholders prior to each review. We will contact the environmental justice community to discuss their concerns with human health risk, including but not limited to, exposure reduction and site-specific fish consumption rates. We will also reconsider the relative importance of mercury from sources other than mining in bioaccumulation.

#### *ASSIMILATIVE CAPACITY*

The next-to-last question warrants additional discussion. In preparing this TMDL, we have assumed that food web complexity is static, and that the food web is identical in the watershed's reservoirs and lakes. However, a 2004 comparison of methylmercury production rates in three reservoirs (see Figure 9.1 and Appendix A, Table A.6) indicates wide variation in production rates.

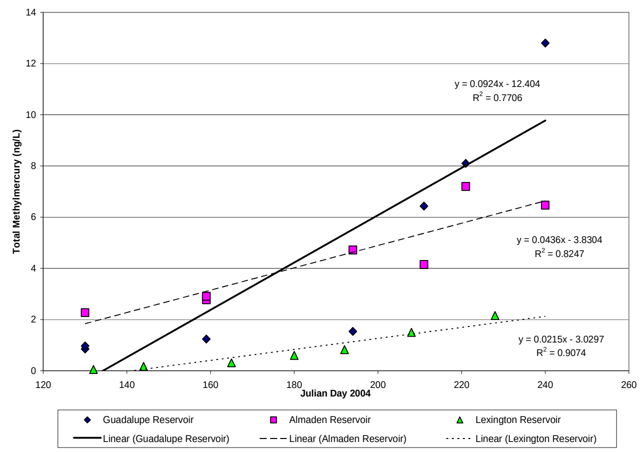


**Figure 9.1 Comparison of Reservoir Methylmercury Production Rates**

*Prepared by Tetra Tech under contract to Water Board*

We have also assumed that assimilative capacity for methylmercury is static. However, on-going research and recent literature indicates that it may be possible to increase the assimilative capacity (i.e., less bioaccumulation despite the same methylmercury production), at least in deep impoundments (i.e., managed water bodies, such as engineered reservoirs and lakes). The Santa Clara Valley Water District's lead researcher notes:

> Almaden Reservoir has a large blue-green algae population—toxic to zooplankton—but other reservoirs do not have this population. The structure of the food web is also an important control on methylmercury bioaccumulation. Methylmercury bioaccumulation increases at increasing tropic levels and with increasing food web complexity. Adding links to the food web increases the overall biomagnification of methylmercury for top level predators. Therefore, actions that alter ecosystem structure can have significant impacts on mercury accumulation.
>
> Most of the methylmercury biomagnification in the food web occurs in the lower tropic levels (e.g., from direct methylmercury uptake by phytoplankton to zooplankton). Methylmercury concentrations in lower organisms can strongly regulate methylmercury concentrations at the top of the food web. Therefore, changes in the community structure or life cycle of lower organisms such as phytoplankton and zooplankton can play a significant role in methylmercury bioaccumulation. For example, smaller phytoplankton that have not lived as long will tend to have lower methylmercury concentrations per unit mass, simply because they have not had as much time to accumulate methylmercury as larger organisms of the same species. So phytoplankton blooms which result in large standing stocks of relatively low-methylmercury phytoplankton can reduce mercury concentrations at the top of the food web, a phenomenon known as "biodilution". Intense zooplankton grazing pressure which keeps

> phytoplankton communities ‘young’ can also keep the average methylmercury concentration per unit mass low, resulting in lower concentrations in top level predators.
>
> This means that it is conceivable that the food web could be managed to prevent biomagnification from reaching harmful levels regardless of what the methylmercury concentration in water is at any point in time (Drury 2006a & 2006b).

Additional support for food web studies and potential manipulations include the following observations from *Inland Fishes of California* (Moyle 2002).

> A keystone predator is a species whose activities can cause changes throughout the ecosystem, usually by changing abundances of favored prey….However, largemouth bass do not appear to play a keystone role under the fluctuating conditions of reservoirs. In some situations their numbers may be regulated by the abundance of their prey. In central California reservoirs where threadfin shad were introduced to provide better forage for largemouth bass, shad actually depress survival of young bass by reducing zooplankton populations needed as food during early life history stages (Ridgway 1988)….It is ironic that plankton-feeding fishes, particularly threadfin shad, which were introduced in part to provide forage for largemouth bass, have also contributed to their decline in some reservoirs, as discussed previously. The interactions between bass and their prey are sensitive to many manipulations because a competitor at early life history stages may become important prey for larger fish (Moyle 2002).

Researchers have recently identified other key factors in methylmercury accumulation in deep impoundments contaminated by atmospheric deposition.

> A three-year (2001-2003) monitoring effort of 14 northeastern Minnesota lakes was conducted to document relationships between water-level fluctuations and mercury bioaccumulation in young-of-the-year (YOY) yellow perch (Perca favescens) collected in the fall of each year at fixed locations. …annual mean concentration ranged by nearly a factor of 2… One likely factor responsible for these wide variations is that annual water-level fluctuations are strongly correlated with mercury levels in YOY perch for both data sets (Sorensen 2005).

In a study of northeastern forests and freshwaters, researchers

> have identified several chemical thresholds to predict high fish mercury: total phosphorus concentrations of less than 30 micrograms per liter [µg/l, parts per billion]; pH of less than 6.0; acid neutralizing capacity of less than 100 [microequivalents] µeq per liter; and dissolved organic carbon of more than 4 mg carbon per liter” (Driscoll et al. 2007).

In a study of weakly stratified impoundments in Voyageurs National Park in Minnesota, researchers found a positive correlation between total organic carbon concentrations and the area of connected wetlands (defined as wetlands adjoining the lakeshore or connected to the lake by a surface inflow). They further found positive correlations between pH, dissolved sulfate and connected wetlands to mercury accumulation in 1-year-old yellow perch (Wiener et al. 2006).

Now let us examine two additional factors that may suggest modifications to targets, allocations, or implementation actions, (a) measurement of hypolimnion methylmercury concentrations, and (b) excess nutrients from controllable sources.

#### Measurement of Hypolimnion Methylmercury Concentrations

Methylmercury data from the hypolimnion of the reference reservoir were used to calculate the methylmercury allocation. These samples were collected from the outlet, not from the reservoir bottom (see Section 7.6, Mercury in Reference Reservoir, and Section 8.2, Impoundment Methylmercury Allocation). Outlet measurements may not reflect conditions at depth. Also, the outlet structures may differ between the impoundments; some reservoirs may have energy dissipaters or non-pressurized pipes with substantial surface exposure to air—both of which may introduce oxygen and change methylmercury concentrations before the discharge reaches the sampling location. Unlike the reservoirs, Lake Almaden does not discharge from the hypolimnion. A study is warranted to evaluate whether there is sufficient difference between each reservoir's hypolimnion and outlet methylmercury to support revising the methylmercury allocation.

#### Excess Nutrients from Controllable Sources

In developing these TMDLs we have not assessed whether excess nutrients from human activities induce oxygen depletion and hence contribute to mercury methylmercury production and bioaccumulation. Potential sources include untreated urban stormwater runoff which, especially in first flush, may contribute excess nutrients from areas served by storm sewers (see Appendix C, Figure C.1). Similarly, excess nutrients may be contributed by malfunctioning on-site disposal systems (septic systems). Areas lacking sanitary sewers include significant stretches of Alamitos and Guadalupe creeks and their tributaries, and an area in the vicinity of Lake Almaden (see Appendix C, Figure C.2).

In summary, several factors may suggest modifications to targets, allocations, or implementation actions. The food web, water-level fluctuations, total phosphorus, pH, acid neutralizing capacity, dissolved organic carbon, dissolved sulfate and the area of connected wetlands may all play a role in the bioaccumulation of mercury, and may explain differences between the different impoundments in the Guadalupe River watershed. Some of these may be controllable water quality factors, and may support adding actions in the course of adaptive implementation that increase assimilative capacity. Alternatively, additional watershed studies may support site-specific methylmercury allocations, for example, due to differences in outlet structures. Lastly, the identification of excess nutrients from controllable sources, and identification of the role nutrients play in methylmercury production, may support adding nutrient source control to the implementation plan.

### 9.8 Water Board Implementation Actions

The Water Board will undertake the actions described in Table 9.5, as necessary, to ensure implementation of the Guadalupe River watershed mercury TMDL.

| Table 9.5 Water Board Actions |
|---|
| • Issue Water Code § 13267 technical report requirements, Water Code § 13304 cleanup and abatement orders, CWA Section 401 certifications, and other orders as necessary to implement the TMDLs and attain the targets |
| • Issue Water Code § 13267 requirements as necessary to obtain additional information needed to inform implementation and achievement of these TMDLs |
| • In coordination with responsible parties, monitor progress toward attainment of targets and compliance with the implementation plan |
| • Assist responsible parties in identifying funding mechanisms for implementation and monitoring |
| • Report annually to the Board and stakeholders on progress in implementation of management measures and attainment of targets, including discussion of options for additional regulatory action and follow-up, as needed. |

### 9.9 Monitoring Program

The monitoring program together with the special studies (Section 9.10) will measure progress in attaining the goals of this TMDL project and inform the adaptive implementation process (Section 9.7). Specifically, the monitoring program encompasses the following:

1. Monitoring to ensure continued effectiveness of erosion control measures to reduce discharges of mercury mining wastes and/or mercury-laden sediment (applicable to mercury mines and depositional areas)
2. Monitoring of mercury load at the points of discharge to demonstrate progress in reducing loads (applicable to mercury mines, and reservoirs and lakes)
3. Fish tissue mercury monitoring to assess progress in attaining targets (applicable to mercury mines, and reservoirs and lakes)
4. Monitoring of mercury load to San Francisco Bay to assess progress in attaining the legacy and urban stormwater runoff mass load allocations assigned by the Bay mercury TMDL (applicable to mercury mines, urban stormwater runoff, and reservoirs and lakes)
5. Special studies to inform adaptive implementation of these TMDLs (Section 9.10) (applicable to mercury mines, urban stormwater runoff, and reservoirs and lakes)

The Water Board will compel the responsible parties to conduct monitoring through Water Code §§ 13267 and 13304 orders, and other authorities as needed, as described in

Sections 9.3–9.6. Although the responsible parties are required to satisfy the monitoring requirements individually, the Water Board encourages a coordinated watershed approach particularly for 3) mercury in fish tissue and 4) loads to San Francisco Bay. The Water Board will collaborate with other resource agencies to coordinate fish monitoring, to leverage their expertise and, where possible, to achieve multiple objectives.

#### *Coordinated Watershed Monitoring Program*

The responsible parties may satisfy monitoring requirements 3–5 through a coordinated effort. Fish mercury monitoring is best undertaken in a coordinated effort, because fish integrate methylmercury over time and space. Monitoring of legacy (i.e., mercury mining waste) and urban stormwater runoff mercury discharges to San Francisco Bay is best undertaken in a coordinated effort, because this load to the Bay is from a combination of sources and responsible parties. The Water Board encourages a coordinated watershed approach to monitoring, and will consider reducing or waiving monitoring requirement 2, based on progress in implementation and participation in coordinated watershed monitoring. To participate in the coordinated watershed monitoring program, submit the coordinated watershed monitoring plan for review and approval by the Executive Officer no later than October 15, 2009.

#### *Effectiveness of Mining Waste Erosion Control Measures*

The purpose of this monitoring is to ensure that the measures employed to reduce and control erosion of mercury mining waste are performing effectively, and if not, to determine why not, and to fix the problem. By effectively, we mean at least as well as specified in the construction design documents.

As described in Section 9.3, the parties responsible for mercury mining waste in the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines will be required to conduct this monitoring through CWC § 13267 requirements or other Water Board authorities. This TMDL project requires the monitoring plan(s) to be submitted by October 15, 2009.

As described in Section 9.5, the applicants for CWA Section 401 certifications are the parties responsible for mercury mining waste in depositional areas and will be required to conduct this monitoring. Implementation is phased so that erosion control actions will be required first at mercury mines, and later downstream at depositional areas. Monitoring plans (and monitoring) will be required by CWA Section 401 certifications at downstream depositional areas.

Monitoring should be tailored to the location—landscape or creek. Mine site areas requiring erosion control may include both landscape and creek areas, because historically mercury mining waste was frequently disposed in creeks.

### Landscape Erosion Control Monitoring

Monitoring plans will be required to address the following questions regarding the effectiveness of erosion control measures to prevent or reduce stormwater discharges of mercury mining waste and/or mercury-laden sediment:

- What is the design level of performance? Are the erosion control measures performing at least as well as designed?
- If not, why not? What is necessary to improve performance to the design level? How soon can these measures be implemented?
- How turbid is the stormwater at each point of discharge? How does it vary between discharge locations? How does it compare to the turbidity of the receiving surface water? Does the design level of performance appear to be adequate?
- If not, why not? What is necessary to improve performance to an adequate level? How soon can these measures be implemented?

The following are suggested components for monitoring plans for landscape projects (i.e., projects not located within the banks of a creek or river). Erosion control effectiveness monitoring may consist of repeated visual inspections and photographs of the construction project and adjacent landscape. Within six weeks after completion of construction, the responsible party will be required to submit as-built plans, showing permanent photo-points. Additionally, parties will provide site maps with the photo points clearly located, and immediate post-construction photo documentation attached.

In the first five years after construction, erosion control effectiveness will be required to be evaluated at least twice annually: once during a storm event, and again late in the dry season. Subsequently, erosion control effectiveness will be required to be evaluated at least once annually late in the dry season.

Storm event monitoring should be timed to occur when the ground is saturated. Storm event monitoring may consist of visual inspection and photo documentation of both the erosion control measures and downstream waters. Visual inspection of the erosion control measures is required to confirm the measures are performing as designed, and are minimizing discharges of mercury mining wastes. Visual inspection of downstream water clarity is required to confirm that the erosion control measures are preventing excessive turbidity.

Dry season monitoring will be required to consist of a visual inspection and photo documentation of the erosion control construction site, for areas lacking vegetative cover or other evidence of soil erosion. These visual clues are most obvious late in the dry season when vegetation is dormant.

Some erosion control projects may include excavation and disposal of mining waste, re-contouring of the landscape, and revegetation. Consequently, some of these excavations may be designed to achieve the naturally-occurring concentration of mercury in local surface soil. Section 9.10 suggests methods for calculating goals for specific cleanup projects at mercury mine sites.

#### Creek Erosion Control Monitoring

Monitoring plans will be required to address the following questions regarding the effectiveness of erosion control measures to prevent or reduce stormwater discharges of mercury mining waste and/or mercury-laden sediment:

- What is the design level of performance? Are the erosion control measures performing at least as well as designed?
- If not, why not? What is necessary to improve performance to the design level? How soon can these measures be implemented?

The following are suggested components for monitoring plans for creek projects (i.e., projects located within floodplains, banks, and beds). Erosion control effectiveness monitoring may consist of repeated surveys and photographs of each construction project and the adjacent landscape. Within six weeks after completion of construction, the party responsible for the project will be required to submit as-built plans including monumented cross-sections and profiles of the channel, floodplain, and terraces in the project area. Permanent photo points and survey locations will be established and recorded on the as-built plans. Additionally, responsible parties will be required to submit a site map with the photo survey points clearly located, and immediate post-construction photo documentation attached.

The purpose of the monumented cross-sections, profiles, and photographs is to track changes in channel plan form, dimensions, and slope; and changes in hillslopes, landscape, and vegetation subsequent to construction of erosion controls. Profiles and cross-sections will be surveyed at photo documentation points located not less than 10 channel widths apart on the stream channel, and at time intervals of no less than three years in order to provide a record of changes for ten years after construction.

As-built plans for areas to be stabilized with re-vegetation, and projects that incorporate soil bioengineering systems, will contain construction specifications for geotextile fabrics, soil bioengineering systems, seeding, container plants, plugs, and other re-vegetation and stabilization methods. Responsible parties will be required to routinely check the operations and performance of irrigation systems, if used, to assure their effectiveness.

Plants, including plants used in soil bioengineering systems, that do not survive to thrive within a three year period following planting will be required to be replaced. The performance goal for plants and soil bioengineering systems is eighty-five percent plant survival (percentage as compared to the as-built plans) within five years.

#### Landscape and Creek Monitoring Reports

Responsible parties will be required to submit annual erosion control effectiveness monitoring reports to the Executive Officer of the Water Board. These reports will describe any significant changes made to an erosion control construction site and areas both up and down hill influenced by the site. If additional measures were needed for landscape projects to reduce the erosion of mercury mining waste, the annual report will describe the measures implemented. If additional measures are needed for creek projects to increase floodplain, creek bank, or creek bed stability or improve vegetation survival, the responsible parties will propose additional measures in their annual reports; construction of these additional measures is subject to Water Board review and approval.

#### *MONITORING OF MERCURY LOAD TO WATERS OF THE GUADALUPE RIVER WATERSHED*

The purpose of this monitoring is to demonstrate progress over the 20-year implementation timeframe in reducing loads of mercury from mining waste to surface waters, and loads of methylmercury to downstream surface waters, at the points of discharge. Two categories of responsible parties will be required to conduct this monitoring. We first discuss the requirements relating to mercury mining waste responsible parties, and then for the methylmercury production responsible party.

As described in Section 9.3, the parties responsible for mercury mining waste in the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines will be required to conduct this monitoring through CWC § 13267 requirements or other Water Board authorities. This TMDL project requires the monitoring plan(s) to be submitted by October 15, 2009.

Storm water monitoring plans will be required to quantify the load of mercury discharged to surface waters by either of the following methods:

1. Quantitatively demonstrate declines in the annual mercury load using data on flow and water column mercury concentrations, or
2. Quantitatively demonstrate that the annual median suspended sediment mercury concentration is declining using water column mercury data collected on the rising limb and peak of the hydrograph during the largest storms each year.

The Water Board will consider waiving the above requirement, on an individual basis, if the responsible party both makes substantial progress on abating discharges of mining waste and participates in the approved coordinated watershed monitoring program. Next, we discuss the requirements relating to methylmercury production.

As described in Section 9.4, the District is responsible for methylmercury production in, and discharges from, lakes and reservoirs. The District will be required to conduct monitoring of loads of mercury and methylmercury discharged from reservoirs and lakes through CWC § 13267 requirements, if necessary. The District's monitoring plan will be required to quantify dry season loads of methylmercury accumulated in and discharged from reservoirs and lakes, using methods similar to Tetra Tech's (see Section 4.4), and wet and dry season loads of mercury discharged from reservoirs by either of the following methods:

1. Quantitatively demonstrate declines in the annual mercury load using data on flow and water column mercury concentrations, or
2. Quantitatively demonstrate that the annual median suspended sediment mercury concentration is declining using water column mercury data collected during discharges with highest turbidity each year.

The Water Board will consider waiving the above requirement to the District if the District both makes substantial progress on the technical studies of methylmercury production and participates in the approved coordinated watershed monitoring program.

#### *FISH TISSUE MERCURY MONITORING*

The purpose of this monitoring is to demonstrate progress over the 20-year implementation timeframe of this TMDL project in attaining the fish tissue mercury targets.

Several parties will be required to conduct fish tissue mercury monitoring. As described in Section 9.3, the parties responsible for mercury mining waste in the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines will be required to conduct this monitoring through CWC § 13267 requirements or other Water Board authorities. This TMDL project requires the monitoring plan(s) to be submitted by October 15, 2008. Also, as described in Section 9.4, the District will be required to conduct fish monitoring, which if necessary will be compelled through CWC § 13267 requirements.

This fish mercury monitoring is best undertaken in a coordinated effort, because fish integrate methylmercury over time and space. Therefore, the Water Board encourages a coordinated watershed approach to monitoring, particularly for mercury in fish tissue.

Fish monitoring plans will be required to address the following questions regarding trends in fish tissue mercury concentrations:

- What is the seasonal and inter-annual variation in fish mercury in the first 5 years of implementation, for remediation effectiveness indicators and target fish?
- What is the trend in fish tissue mercury concentrations in target fish over the subsequent 15 years of implementation?

The following are suggested components for a fish monitoring program to address the above questions. Quantify seasonal and inter-annual variation in fish mercury by monitoring fish at least annually in the first 5 years of Phase 1 (years 1–5). Subsequently, through Phase 2 (years 6–20), quantify the trend in fish mercury by monitoring fish at least every five years. In years 1–5, measure mercury concentrations in age-1 largemouth bass (remediation effectiveness indicators, described below) in reservoirs and lakes in the fall, soon after mixing occurs. Also in years 1–5, measure mercury concentrations in fish, both 5–15 cm and 15–35 cm in length, of species consumed by wildlife (target fish), and preferably in California roach (remediation effectiveness indicators) at all sampling locations just before the belted kingfisher and osprey breeding season. Twice in years 1–5, repeat this target fish monitoring during the belted kingfisher and osprey breeding season. Monitor water quality with fish collection for total mercury, dissolved mercury, total methylmercury, dissolved methylmercury, suspended sediment, and general water quality parameters.

The initial fish (and water) sampling sites should include reservoirs and lakes, reference sites (i.e., no mercury mining, no urban stormwater runoff), up- and downstream locations, surface waters receiving mercury mining waste, previous sites, and include the following: Guadalupe Reservoir site 1 (S1), and one site on Guadalupe Creek (S2); Almaden Reservoir (S3), and two sites on Alamitos Creek (S4 and S5); Calero Reservoir (S6), and one site on Arroyo Calero Creek (S7); two sites on the Guadalupe River (S8 and S9); Lake Elsman (S10), Lexington Reservoir (S11) , Vasona Lake (S12), and one site on Los Gatos Creek (S13); and one site on each of Ross (S14) and Canoas (S15) creeks. The sampling sites may be changed upon approval of the Executive Officer.

The following provides the protocol for interpreting fish mercury data from large fish that humans consume. The targets for this TMDL project were developed for methylmercury (see Section 5). Because nearly all mercury in fish is methylmercury in the muscles (Grieb et. al. 1990), skinless filet samples may be analyzed for total mercury. The total mercury results from such sampling and analysis may be interpreted as equal to methylmercury concentrations. Interpretation of prey fish mercury concentrations is somewhat different.

The following provides the protocol for handling and interpreting prey fish mercury data. The protocol for handling samples of prey fish should include packing the samples in water (e.g., in a zip-lock plastic bag with deionized water) to prevent desiccation. About ninety percent of the mercury in small, whole prey fish is methylmercury (Slotton 2007). Therefore, prey fish methylmercury concentrations may be estimated as ninety percent of the total mercury in whole fish. The prey fish samples collected in 2004 and 2006 were eviscerated. Most of the inorganic mercury in these small fish is contained in the liver, which is removed by evisceration (Slotton 2007). Therefore, the total mercury results from eviscerated fish may be interpreted as equal to methylmercury concentrations. Data from fish of 15.0 to 15.4 cm in length should be compared to the lower and more protective target of 0.05 mg/kg.

The following describes the remediation effectiveness indicators. Whereas grab water methylmercury samples provide an instantaneous and site-specific measure of methylmercury, age-1 fish provide an integrated measure of methylmercury over time (one year) and space (their forage area within a given water body). Age-1 largemouth bass data from reservoirs and lakes in 2004 confirmed low sample variability, and therefore excellent utility for measuring environmental response to implementation actions. Similarly, age-1 California roach in creeks and the river had low sample variability. The roach, too, provides excellent utility for measuring environmental response to implementation actions.

Water Board staff assume that it will take several years for methylmercury levels in the water column to reach equilibrium after mining waste source control measures are implemented. During the period between completion of mining waste remediation actions and attainment of equilibrium, the best method for evaluating mining waste remediation effectiveness may be to compare newly collected age-1 fish mercury concentrations to the 2004 baseline age-1 data (see Table 9.6). Staff expects that several years after mining waste source control implementation actions are completed; after methylmercury production controls are formulated; and within months of deploying methylmercury production controls, mercury concentrations in age-1 fish will attain the TL3 wildlife target of 0.05 mg/kg (applicable both to fish less than 50 mm length and those between 50 to 150 mm length). We further expect that it will take up to several more years of methylmercury production controls before mercury in older fish attain the TL3 wildlife target of 0.10 mg/kg in 150-300 mm fish, and a longer timeframe for mercury concentrations to decline in larger fish which humans consume.

Therefore, staff proposes to use the 2004 baseline age-1 fish data to evaluate remediation effectiveness in the years before the targets are attained.

**Table 9.6 Remediation Effectiveness Indicator: Age-1 Fish 2004 Baseline Data**

Impoundments: Largemouth Bass

- Guadalupe Reservoir: 0.83 mg/kg
- Almaden Reservoir: 0.96 mg/kg
- Almaden Lake: 0.9 mg/kg
- Calero Reservoir: 0.21 mg/kg

Creeks & River: California Roach

- Alamitos Creek at Harry Road: 0.28 mg/kg
- Alamitos Creek at Greystone Lane: 0.15 mg/kg
- Guadalupe Creek at Meridian Ave.: 0.39 mg/kg
- Guadalupe River at Foxworthy Ave.: 0.15 mg/kg
- Guadalupe River at Coleman Ave.: 0.08 mg/kg

#### *MONITORING OF MERCURY LOAD TO SAN FRANCISCO BAY*

The purpose of this monitoring is to (a) demonstrate progress over the 20-year implementation timeframe in attaining the legacy and urban stormwater runoff mercury allocations assigned by the Bay mercury TMDL, (b) improve the understanding of dissolved and particulate mercury and methylmercury loads, and (c) verify the watershed's sediment load to the bay. This monitoring of legacy and urban stormwater runoff mercury discharges to San Francisco Bay is best undertaken in a coordinated effort, because this load to the Bay is from a combination of sources and responsible parties, and generally can be measured at one location.

Many parties will be required to conduct this monitoring. As described in Section 9.3, the parties responsible for mercury mining waste in the New Almaden Mining District and the Guadalupe, Santa Teresa, and Bernal mercury mines will be required to conduct this monitoring through CWC § 13267 requirements or other Water Board authorities. This TMDL project requires the monitoring plan(s) to be submitted by October 15, 2009. As described in Section 9.4, the District is responsible for discharges from reservoirs and lakes to downstream waters, and will be required to conduct this monitoring by CWC § 13267 requirements, if necessary. As described in Section 9.6, urban stormwater runoff permittees are provided several methods in the San Francisco Bay mercury TMDL to demonstrate compliance with their wasteload allocation. Two of these three methods are the same as for the Guadalupe River watershed mercury TMDL. Consequently, the urban stormwater runoff permittees may find it advantageous to participate in this portion of the coordinated watershed monitoring program.

Monitoring plans will be required to quantify the load of mercury discharged to San Francisco Bay by either of the following methods:

1. Quantify the mercury load as a five-year annual average mercury load using data on flow and water column mercury concentrations.
2. Quantitatively demonstrate that the mercury concentration of suspended sediment that best represents sediment discharged from the watershed to San Francisco Bay is below the suspended sediment target.

The following are suggested components for this loads monitoring program: (a) measure turbidity continuously through the wet season; (b) collect grab samples of first flush (runoff from first significant storm event); and (c) collect grab samples during peak storms in 4 out of 5 years, and both small and peak storms in at least 1 out of 5 years. Analyze grab samples (b and c) for mercury species, nutrients, and general water quality parameters.

The primary sampling location is in the Guadalupe River near Highway 101 (Figure 3.6). In the first five years of Phase 1 (years 1–5), continuous and grab sampling will be conducted near Highway 101, and at Gage 23b (Figure 3.6). Additionally, the Water Board may require grab sampling at other locations, on occasion, to assess the contribution from specific areas and/or sources. Subsequent sampling (years 6–20) will occur, at a minimum, near Highway 101.

### *9.10 Special Studies*

The special studies described below may be needed to provide information to improve the scientific understanding of mercury cycling in the watershed, and verify assumptions used in developing these TMDLs. Results of these special studies will inform adaptive implementation of the TMDL and the implementation plan. The special studies should address the following questions.

1. How do the reservoirs and lakes in this watershed differ from one another? Factors to consider include, but are not limited to, area of connected wetlands, food web, water chemistry (phosphorus, pH, acid neutralizing capacity, and dissolved organic carbon), water level fluctuations, and infrastructure (outlet structure). Do outlet samples adequately represent hypolimnetic methylmercury concentrations for each reservoir? How significant are these differences?
2. Is it possible to increase the assimilative capacity for methylmercury in reservoirs and lakes? Is it feasible to do so? If it is feasible, does it result in attaining the fish tissue targets? How does it affect the food web, and is the resulting food chain multiplier from large (>15 cm) TL3 to large TL4 fish significantly different from 2? If it is significantly different, where and at what frequency is monitoring of larger fish which humans consume warranted?

If the monitoring program does not provide the information to answer these questions, the District will voluntarily conduct or cause to be conducted studies 1 and 2, or equivalent or alternative studies with prior approval of the Water Board Executive Officer. As necessary, the Water Board may compel the District to undertake these studies in accordance with Water Code § 13267 requirements. Completing study 1 within the first five years of Phase 1 (by December 31, 2013), and completing study 2 within the 10-year duration of Phase 1 (by December 31, 2018), would meet the following goal for the first phase of implementation: “completing studies of methylmercury and bioaccumulation controls in reservoirs and lakes”.

3a. What effect do the reservoir and lake control measures have on methylmercury bioaccumulation downstream? Are the fish targets attained downstream?

3b. If not, what factors contribute to methylmercury production and bioaccumulation in creeks and rivers? Factors to consider include, but are not limited to, shallow impoundments, excess nutrients, stagnant pools, shade cover, and aquatic vegetation.

If the monitoring program does not provide the information to answer these questions, the District will voluntarily conduct or cause to be conducted study 3a, or study prior approval of the Water Board Executive Officer. As necessary, the Water Board may compel the District to undertake these technical studies in accordance with Water Code § 13267 requirements.

If the fish targets are not attained downstream by methylmercury controls in the reservoirs and lakes, the Water Board may require that the District together with the responsible parties identified for the New Almaden Mining District and the Guadalupe, Santa Teresa and Bernal mercury mines, and urban stormwater runoff permittees, to conduct study 3b, or equivalent alternative study. Study 3B will be subject to Water Board Executive Officer approval, and will occur either voluntarily or in accordance with Water Code § 13267 or NPDES stormwater permit requirements.

Completing studies 3a and 3b within the first 5 years of Phase 2 (by December 31, 2023) would support the Water Board’s effort to identify whether methylmercury production and bioaccumulation controls are necessary in shallow impoundments, in accordance with the adaptive implementation program.

4. Where the TL3 50–150 mm target is attained, is mercury in fish that Forster’s terns consume (fish less than 50 mm in length), at or below 0.05 mg/kg? Where the TL3 >150–350 mm target is attained, is mercury in fish that ospreys consume (TL4 >150–350 mm target), at or below 0.20 mg/kg? If these assumptions pertaining to proportional bioaccumulation are not valid for this watershed, what monitoring should be conducted to support a revised water quality objective and target to protect piscivorous wildlife?
5. Where the larger TL3 target is attained (in fish >150–350 mm), is the smaller TL3 target also attained (fish 50–150 mm)? If so, how should the monitoring frequency for the smaller TL3 target be reduced?

If the monitoring program has not already provided the information to answer these questions, the Water Board will conduct studies 4 and 5. Completing study 4 within the 10-year duration of Phase 1 (by December 31, 2018), would provide timely information to support whether the water quality objectives require revision through the adaptive implementation process. The timing for study 5 is contingent upon the effectiveness of methylmercury controls.

#### *CALCULATING THE MINING WASTE CLEANUP GOAL*

This section provides some preliminary ideas on how responsible parties may conduct a special study to calculate ambient soil mercury concentrations for review and approval by Water Board staff prior to implementing mining waste source control actions. As stated above, the mining waste allocations to mercury mines are expected to be met by erosion control actions. Some erosion control measures may be designed to attain natural background mercury concentrations (e.g., excavate mining waste down to ambient, pre-mining background concentrations.)

One method is described in the Central Valley Water Board's Sulphur Creek Mercury TMDL, where staff used the concept of a mineralized zone surrounding mercury deposits to propose a preliminary cleanup goal for mercury in eroded soil fines. Based on mercury concentrations found at the periphery of the mineralized zone in the lower Sulphur Creek watershed, staff proposed a goal of no more than 3 mg/kg of mercury from eroded soil fines in runoff and the stream below mine sites—a goal that is approximately double the concentration found at the periphery (CVRWQCB 2004).

The periphery of the mineralized zone of the New Almaden Mining District has not been mapped in the same detail as in the Sulphur Creek area. Responsible parties may undertake a monitoring program to establish a perimeter surface soil mercury concentration in the New Almaden Mining District. The sampling and analysis plan will describe how sampling locations will be selected to avoid contamination by mining waste and historic local deposition from ore roasting. The sampling and analysis plan will be submitted to the Water Board staff for review and approval prior to sampling.

To plan cleanup and excavation work, some understanding of local soil and rock types, their relationships to mercury concentrations, and how historic mining operations processed and used mined materials is essential. Silica carbonate is the host rock for cinnabar mercury ore in the New Almaden Mining District (Bailey & Everhart 1964). Other soil types include Franciscan sandstone, Franciscan greenstone, chert, and serpentine. Data from pre-remediation mercury samples collected in Almaden Quicksilver County Park from each of these soil types in non-mined areas are plotted on Figure 9.2 (Dames & Moore 1989) (see Appendix A, Tables A.4 and A.5). Median mercury concentrations in these soil samples were 24 mg/kg in silica-carbonate soils and 0.84 mg/kg in other soils (indicated as "All NonMineNonSiCarb" on Figure 9.2; medians ranged from 0.16 mg/kg at CO-6, the hillside north of Randol Trail, to 3.4 mg/kg at CR-2 in native road base). In contrast, mercury concentrations in Franciscan greenstone downwind of the Hacienda Furnace Yard (where roasting cinnabar led to mercury emissions into the air) ranged from 23–79 mg/kg (*ibid*.)

The principal clue that miners used to locate ore bodies in the New Almaden Mining District was surface outcrops of silica-carbonate soils, many of which they excavated. Many of the silica-carbonate outcrops still standing today likely are located in close proximity to former ore-roasting facilities, whether permanent or mobile furnaces. Dames & Moore collected surface soil samples from the remaining outcrops from 0–2 inches below surface, and therefore these results likely included mercury from local deposition from nearby ore-roasting chimneys (*ibid*.) Consequently, the samples of silica-carbonate soils described above are likely to contain elevated mercury from nearby ore roasting facilities and therefore they do not adequately represent natural soil mercury concentrations.

Responsible parties may conduct a monitoring program to calculate site ambient, pre-mining background surface soil mercury concentrations to use as site-specific cleanup levels. These determinations may be made by soil type. An initial sampling effort may be necessary to collect depth-profile samples (for example, 5 cm increments from to 50 cm below surface) to evaluate historic local deposition from ore roasting, and determine the appropriate sample depth interval. For example, Rytuba found that the ambient mercury concentration is reached at depth of 33 cm at New Idria:

> A typical vertical profile of soils impacted by long term furnace release is shown in [Figure 9.3] from the New Idria district, the second largest producer of mercury in North America. The background concentration of mercury, 100 ng/g (ppb) [0.1 mg/kg], is reached at a depth of 33 cm. (Rytuba 2002)

This is the same concentration (0.1 mg/kg) as the bottom sediments in the reference reservoir, which is nearly equal to the Bay Area background (nonurban) soil mercury concentration (Section 8.4).

The sampling and analysis plan will characterize natural variability of mercury concentrations by subwatershed, include a statistical power analysis to support the quantity of samples proposed, and describe how sampling locations will be selected to avoid contamination by mining waste and historic local deposition from ore roasting. This plan will be submitted to the Executive Officer of the Water Board for review and approval prior to sampling.

The natural soil mercury concentrations may be applied in at least two ways to source control actions: (1) erosion-control projects in the New Almaden Mining District can be sub-divided by the two soil types. The mercury concentration appropriate to each soil type then applies; or (2) a project-specific median mercury concentration may be calculated based on the relative proportions of the two soil types and applied to the entire project site.

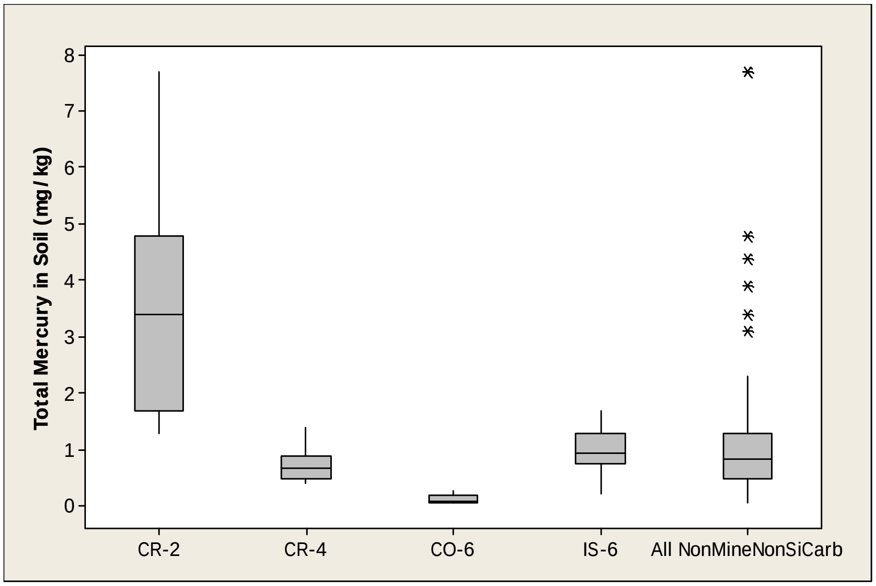


**Figure 9.2 Non-mined Area Surface Soil Mercury Concentrations (1989)**

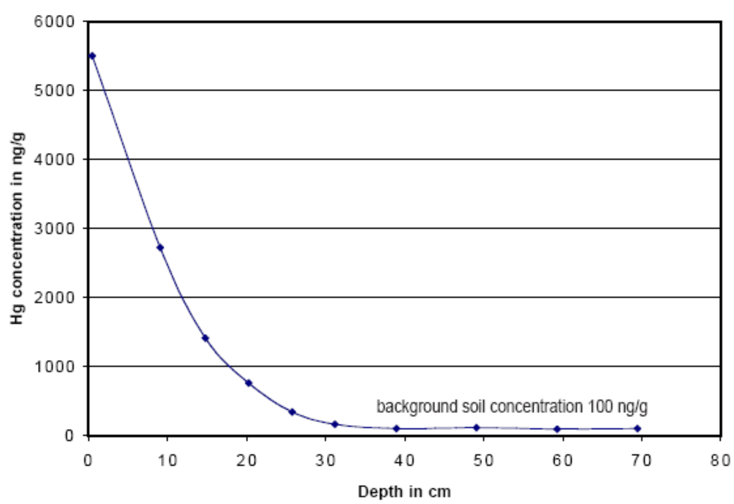


**Figure 9.3 New Idria Soil Mercury Profile**

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# 10. Regulatory Analyses

This section includes regulatory analyses required for establishing new water quality objectives, and TMDLs and implementation plans for achieving TMDLs. The Basin Plan amendment proposed to reduce mercury in the Guadalupe River watershed includes the following regulatory provisions:

- Two freshwater fish tissue methylmercury water quality objectives
- TMDLs, targets, and allocations
- Required TMDL implementation actions

***ORGANIZATION OF THIS SECTION***

The regulatory analyses are presented in the following sections:



## *10.1 Regulatory Framework*

Agencies with permit review or approval authority over the implementation of reasonably foreseeable means of compliance include:

**San Francisco Bay Regional Water Quality Control Board**

Issues Clean Water Act Section 401 Water Quality Certifications, required to conduct dredging or filling of waters of the U.S.; NPDES permits, Waste Discharge Requirements, and Cleanup and Abatement Orders for discharges that pollute or threaten to pollute surface or groundwater, and other orders as necessary to enforce the Porter Cologne Water Quality Control Act of 1969. Enforces its Order R2-2002-0028, *Waste Discharge Requirements and Water Quality Certification for Santa Clara Valley Water District, Multi-Year Stream Maintenance Program, Santa Clara County*, which sets conditions for stream maintenance and flood control projects below 1,000 ft. elevation.

**California Office of Environmental Health Hazard Assessment**

This office has issued a fish consumption advisory for Guadalupe, Calero, and Almaden reservoirs; the Guadalupe River; Guadalupe and Alamitos creeks, and "the associated percolation ponds" (groundwater recharge ponds) along the river and creeks. The advisory states, "Because of elevated mercury levels in fish, no one should consume any fish taken from these locations."

**California Department of Toxic Substances Control**

Issues orders in accordance with Chapter 6.8 of Division 20 of the California Health and Safety Code. Regulates handling, transportation, and disposal of hazardous waste, such as calcines and mercury-laden soils likely to be involved in future projects undertaken in compliance with the Basin Plan amendment.

**U.S. Army Corps of Engineers**

Issues Clean Water Act section 404 permits for discharges to waters of the United States and dredging and fill projects in navigable waters, incorporating conditions of its nationwide permits

**National Oceanic Atmospheric Administration/National Marine Fisheries Service (NOAA/NMFS)**

With the U.S. Fish and Wildlife Service, conducts Endangered Species Act Section 7 consultation for effects to migratory and endangered fish species; enforces the Magnuson-Stevens Fishery Conservation and Management Act, under which it regulates fall-run Chinook salmon in the Guadalupe River watershed.

**U.S. Fish and Wildlife Service**

With NOAA/NMFS, conducts Endangered Species Act Section 7 consultation for possible effects to listed federal species. Enforces the Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act.

**California Department of Fish and Game**

Issues permits for incidental takes of state listed species under Sections 2081(b) and (c) of the California Endangered Species Act, if specific criteria are met, and Section 2081 consultation for effects to listed species.

If the Department determines that an activity may substantially adversely affect fish and wildlife resources, the applicant must prepare a Stream Alteration Agreement that includes reasonable conditions necessary to protect those resources. Compliance with the California Environmental Quality Act (CEQA) is also required.

**Santa Clara Valley Water District**

Responsible for drinking water quality and supply, flood protection, and watershed management in Santa Clara County. Issues permits under its Water Resources Protection Ordinance 06-1, and District Ordinance 90-1 (regulating water wells and excavation intersecting groundwater aquifers in Santa Clara County); operates reservoirs in the County.

**Municipalities including City of San José and County of Santa Clara**

Issue building, grading, and utilities permits; enforces standards and ordinances related to noise, tree removal/preservation, scenic area preservation, and geologic hazards including earthquakes and landslides.

## 10.2 Regulatory Analyses Required to Establish New Water Quality Objectives

For the proposed water quality objectives, this section contains the analyses required by the California Water Code (CWC §13241 and §13242), federal water quality criteria requirements (40 Code of Federal Regulations [CFR] §131.11), and state and federal anti-degradation requirements.

### CALIFORNIA WATER CODE § 13241

The Water Board is required under CWC §13241 to adopt such water quality objectives as in its judgment will ensure the reasonable protection of beneficial uses and the prevention of nuisance. The Water Code identifies six factors that must be considered when establishing water quality objectives:

(a) Past, present, and probable future beneficial uses of water

(b) Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto

(c) Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area

(d) Economic considerations

(e) The need for developing housing within the region

(f) The need to develop and use recycled water. (CWC §13241)

We consider these factors in the following analysis.

#### Past, Present, and Probable Future Beneficial Uses

The existing and potential beneficial uses of waters in the Guadalupe River watershed include the following: cold freshwater habitat; warm freshwater habitat; wildlife habitat; preservation of rare and endangered species; fish migration; fish spawning; freshwater replenishment; groundwater recharge; municipal and domestic water supply; water contact recreation; and noncontact water recreation. Of these many beneficial uses, only human consumption of fish (water contact recreation) and wildlife consumption of fish (preservation of rare and endangered species, and wildlife habitat) are impaired because of high concentrations of mercury. When the proposed mercury water quality and fish tissue objectives are attained, these beneficial uses will be restored and protected.

#### Environmental Characteristics of the Hydrographic Unit

The Guadalupe River watershed (Figure 3.2) is a hydrologic subunit of the Santa Clara Basin and drains approximately 170 square miles. Its headwaters originate in the Santa Cruz Mountains near the summit of Loma Prieta (elevation 3,790 feet).The Guadalupe River begins at the confluence of Guadalupe Creek and Alamitos Creek. The Guadalupe River is the dominant drainage in the watershed. It runs from the Santa Cruz Mountains (which separate the South Bay from the Pacific Coast) and flows north through San Jose, through Alviso Slough, and into San Francisco Bay. The Guadalupe River is fed by three tributaries (Ross, Canoas, and Los Gatos creeks) along its northward course to San Francisco Bay. It is tidally-influenced in the vicinity of Alviso Slough.

Land use changes, including mercury mining, salt farming, agriculture, and urban development, have altered the environmental characteristics of the watershed since Europeans settled the Bay

Area. In the vicinity of San Jose the Guadalupe River has been subject to modification dating back at least to 1866, when a canal was dug to control flooding and augment water supply to expanding orchards. Much more recently, Canoas and Ross creeks were realigned and roughly 3,000 feet of the Guadalupe River channel was widened and relocated to allow filling of the original channel for the construction of an expressway.

In addition, six reservoirs, engineered for water conservation, storage, and varying amounts of flood control, operate in this watershed. They include (from east to west) Calero Reservoir on Calero Creek, Almaden Reservoir on Alamitos Creek, Guadalupe Reservoir on Guadalupe Creek, and Lake Elsman, Lexington Reservoir, and Vasona Lake, on Los Gatos Creek. The reservoirs influence the hydrology of the watershed, altering flow schedules by holding back water in wet winters, thereby reducing the floods that punctuated the decades with washouts and flooding. The reservoirs also hold back sediment that otherwise would be transported to the Bay from the surrounding watershed in wet winters.

Lake Almaden also influences the hydrology of the watershed. Lake Almaden is the site of a former gravel quarry, not a reservoir. Consequently, in the winter it acts more like a river than a reservoir, and although it too holds back sediment, it holds back much less than the reservoirs.

The proposed TMDLs and implementation plan are designed to resolve mercury impairment in waters downstream of mercury mines and in waters that receive urban runoff in the Guadalupe River watershed (see Figure 1.2). A future TMDL and implementation plan will address mercury impairment in the remaining western portion of the watershed (Los Gatos Creek and its tributaries upstream of Vasona Dam, Lake Elsman, Lexington Reservoir, and Vasona Lake).

#### Water Quality Conditions That Could Reasonably Be Achieved Through the Coordinated Control of All Factors

Coordinated control of the many factors that affect mercury concentrations in fish and waters of the Guadalupe River watershed will result in attainment of the proposed water quality objectives. The following are controllable factors that affect methylmercury concentrations in biota:

- Discharge of mercury mining waste and mercury-laden sediment from inactive mine sites
- Downstream of the inactive mines, discharge of mercury-laden sediment from eroding creek beds, banks and floodplains, shallow impoundments, and percolation ponds
- Discharge of mercury-laden sediment from urban stormwater runoff
- Low dissolved oxygen in the hypolimnion of reservoirs and lakes

The proposed Guadalupe River watershed mercury TMDL project Basin Plan amendment provides a program of coordinated control of these factors by establishing TMDLs, allocations, and an implementation plan. Coordinated control of these factors through the TMDL project will result in water quality conditions that meet the proposed water quality objectives and protect beneficial uses.

#### Economic Considerations

The proposed fish tissue mercury water quality objectives will be implemented through the Guadalupe River watershed mercury TMDL project Basin Plan amendment. Therefore, the economic considerations for the proposed objectives are the same as those identified in Section 10.8 for TMDL implementation. The economic analysis presented Section 10.5fulfills the requirements of California Environmental Quality Act Public Resource Code 21159, and Water Code § 13241.

#### Need for Developing Housing

Neither of the proposed fish tissue objectives would restrict the development of housing in the Guadalupe River watershed or the San Francisco Bay Area, because they do not result in significant economic costs or restrictions related to housing development.

Implementation actions necessary to meet the new objectives are consistent with actions required for Clean Water Act Section 401/404 compliance. (These sections apply to any fill or discharge below the "ordinary high water line" of a water of the United States.) Under these requirements, property owners considering developing housing on land adjacent to waters are required to consider impacts to water quality if the project encroaches on a creek or wetland. Although most creekside parcels affected by the TMDL project are already developed, there are some parcels on Alamitos and Guadalupe creeks where housing could be developed. Erosion control measures for mining waste may be needed on these parcels in order to develop housing. However, these measures also provide creek bank stability, which protects the property (and the investment). Thus, the proposed implementation plan is consistent with existing regulatory requirements, and will not restrict housing development in the Guadalupe River watershed.

#### Need to Develop and Use Recycled Water

The proposed fish tissue objectives are consistent with the need to develop and use recycled water. There are no present restrictions on recycling of water due to mercury. In setting these objectives, the Water Board's intent is to improve water quality and reduce mercury levels in waters of the Guadalupe River watershed.

### *CALIFORNIA WATER CODE § 13242*

Under the California Water Code (CWC), when adopting water quality objectives in the Basin Plan, a program of implementation for achieving the objectives must be included. The program must include, but not be limited to:

(a) A description of the nature of actions which are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private

(b) A time schedule for the actions to be taken

(c) A description of surveillance to be undertaken to determine compliance with objectives (CWC § 13242)

Accordingly, the program of implementation to achieve the proposed water quality objectives for mercury in waters of the Guadalupe River watershed is the Guadalupe River watershed mercury TMDL project. The proposed program of implementation is described in Section 9 (Implementation and Monitoring). The Guadalupe River watershed mercury TMDL project sets forth appropriate actions by public and private entities, a time schedule for actions to be taken, and a monitoring ("surveillance") program to determine compliance with the proposed water quality objectives.

### *CODE OF FEDERAL REGULATIONS § 131.11*

Federal regulations at 40 CFR § 131.11 require states to adopt water quality criteria that protect the designated beneficial use. The criteria must be based on sound scientific rationale and contain sufficient parameters or constituents to protect the designated use. Where multiple use designations exist, the criteria must support the most sensitive uses. For numeric values such as the fish tissue objectives proposed here, the criterion should be based on Clean Water Act § 304(a) guidance (or as modified to reflect site-specific conditions) or other scientifically defensible methods.

Section 5 (Proposed Water Quality Objectives) describes the analyses used to develop the proposed water quality objectives. The U.S. Fish and Wildlife Service have determined that the proposed water quality objectives will protect the most sensitive species in the watershed, piscivorous birds. The proposed objectives also protect human health, and are more protective than U.S. EPA's latest 304(a) criteria guidance for mercury to protect human health (0.3 mg methylmercury per kg fish tissue). In conclusion, the proposed objectives are based on U.S. EPA § 304(a) guidance and protect the most sensitive uses.

#### *State and Federal Antidegradation Policies*

The proposed objectives and TMDLs are consistent with both state and federal antidegradation policies and the protection of water quality and beneficial uses. They are more stringent than the existing numeric water quality objective they will replace. These conclusions are supported by the analysis presented in the following paragraphs.

The proposed water quality objectives must be consistent with both federal and state antidegradation policies. Specifically, California's antidegradation policy, State Water Resources Control Board Resolution 68-16, requires the protection of high quality waters and states that water quality cannot be lowered unless doing so is consistent with the maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses, and will not result in water quality less than prescribed on policies. Resolution 68-16 has been interpreted to incorporate the federal antidegradation policy, which among other things, requires the protection of existing uses and high quality waters unless a lowering of water quality is necessary to accommodate important economic or social development.

The two proposed fish tissue objectives reflect current scientific understanding and are more stringent than the existing Basin Plan four-day average water column objective of 0.025 µg total mercury per liter of water. The existing Basin Plan four-day average objective is based on science from over two decades ago, which was derived to attain 1 mg methylmercury per kg fish tissue. The proposed objectives are based on our current understanding of methylmercury toxicity (i.e., reference doses) for both wildlife and humans. The two proposed objectives are more stringent (0.05 and 0.1 mg methylmercury per kg fish tissue) and will therefore protect beneficial uses and not result in a lowering of water quality.

### *10.3 Peer Review Requirement Under California Health and Safety Code §57004*

In conformance with requirements in California's Health and Safety Code, we submitted the staff report and draft proposed Basin Plan amendment for peer review of the scientific basis of the TMDLs. The peer reviewers are Prof. David L. Sedlak, Department of Civil and Environmental Engineering, University of California, Berkeley; Prof. Desiree Tullos, Biological and Ecological Engineering, Oregon State University; Corvallis, and Michael Josselyn, Professor Emeritus of Biological Sciences, San Francisco State University, California.

The peer reviewers' responses confirmed that the scientific portion of the proposed water quality objectives are based on sound scientific knowledge, method, and practices, and thus satisfy California Health and Safety Code § 57004. Prof. Sedlak wrote,

> In general, I believe that the staff report uses sound scientific practices to address a complicated issue. The TMDL uses fish tissue mercury concentrations as water quality objectives to protect wildlife and humans who consume fish from the affected reservoirs. Most of these guidelines were established as part of previous TMDLs and have undergone extensive external review. The identification of sources, linkage analysis and allocations are based upon data collected recently by the Regional Board's contractor (i.e., Tetra Tech). Although the heterogeneity of the system and its complex hydrology make it difficult to estimate some of the values accurately, the staff has attempted to apply best professional judgment in a way that allows cleanup to begin soon. In my opinion, the adaptive management approach advocated by the staff is superior to spending more time quantifying loadings and sources. (Sedlak 2007)

Professor Tullos wrote, "In summary, taken as a whole, the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices. The analysis of sources, linkages, and allocations are logical and well developed. (Tullos 2007)" Professor Josselyn also expressed his support, "I am very impressed with the thoroughness of the scientific analysis within this document; particularly the conceptual model and data analysis that was undertaken. (Josselyn 2007)"

Professors Sedlak and Tullos raised some questions with respect to our interpretation of fish tissue mercury concentrations in the reference reservoir. In the Staff Report for Peer Review, we had interpreted the small prey fish data as meeting the wildlife target, and large fish data as safe for human consumption of two meals per month. In response to the peer reviewers' concerns, we modified the report to interpret the small prey fish data as exceeding the wildlife target. Consequently, we revised the methylmercury allocation, based on the reference reservoir, to include an explicit margin of safety. This will result in large fish safe for human consumption of four meals per month.

Monitoring and assessment will help us refine our understanding of mercury in the watershed and is supported by all three peer reviewers. However, Professor Tullos expressed concern about monitoring of erosion control measures in creeks. The program description stated that "storm event monitoring shall consist of a visual inspection for excessive turbidity in downstream waters, and if found, determining whether the excessive turbidity is from the erosion control construction site." Professor Tullos found this not to be a "transparent, enforceable, or accepted criterion for evaluating erosion." She further suggested that "substantial effort be applied to developing and committing resources to a scheduled field monitoring plan, using accepted methodology for documenting bed and bank erosion and turbidity sampling."

After consultation with in-house experts, we determined that for erosion control on the landscape, such as at mines, "excessive turbidity" is an appropriate standard. However, we have revised the monitoring requirement for erosion control projects in creeks to include surveying creek cross-sections to evaluate bed and bank stability.

## 10.4 Analysis required by the California Environmental Quality Act

This section presents the results of an environmental impact analysis required under the California Environmental Quality Act (CEQA), and a discussion of economic considerations in compliance with Pubic Resources Code § 21159 [a]. The environmental impact analysis evaluates the reasonably foreseeable environmental impacts of the implementation measures identified in the Implementation Plan (see Section 9). The discussion of economic considerations reviews costs associated with methods that may be used to implement the TMDLs.

The Water Board is the Lead Agency responsible for evaluating the potential environmental impacts of the proposed Basin Plan amendment to establish the fish tissue objectives and the TMDLs for mercury in certain portions of the Guadalupe River watershed (see Figure 1.2). Under the provisions of § 21080.5 of the California Public Resources Code, the California Secretary for Resources has the authority to certify the regulatory programs of state agencies as exempt from the requirements of preparing environmental impact reports and related documents, if the Secretary finds that the program meets the criteria specified in that section of the code. The Basin Planning process of the Water Boards is certified as such a program as described and listed in Article 17, §15251 (g) of CEQA.

Although the Water Board is not required to complete an environmental impact report for such a Certified Regulatory Program, it is not completely exempted from the provisions of CEQA; it must still comply with CEQA's other provisions, including the policy of avoiding significant adverse impacts on the environment where feasible. In order to demonstrate compliance with these requirements, we have produced this Substitute Environmental Documentation that fulfills the requirements of CEQA.

To satisfy CEQA's recommendation to engage the public and interested parties in early consultation about the scope of the environmental analysis, a scoping meeting was held at the Martin Luther King, Jr., Library in San Jose on Thursday, November 8, 2007.

This section of the Staff Report contains the environmental checklist for the proposed Basin Plan amendment and includes the required analyses mentioned above. The explanations following the checklist provide details concerning the environmental impact assessment. Based on this analysis, Water Board staff concludes that adoption of the proposed Basin Plan amendment will not cause significant adverse environmental impacts.

### 10.4.1 Environmental Checklist

Under the Water Board's certified regulatory program for basin planning, the Water Board must satisfy the substantive requirements of the California Code of Regulations, Title 23 § 3777(a), which requires a written report that includes a description of the proposed activity, an alternatives analysis, and an identification of mitigation measures to minimize any significant adverse impacts. § 3777(a) also requires the Water Board to complete an environmental checklist as part of its substitute environmental documents. Additionally, the Water Board must comply with Public Resource Code § 21159 when adopting performance standards such as those in the proposed Basin Plan amendment. Public Resources Code §21159 requires the environmental analysis to include: (1) the reasonably foreseeable environmental impacts of the method of compliance; (2) the reasonably foreseeable mitigation measures; and (3) the reasonably foreseeable alternative means of compliance with a rule or regulation. The analysis must take into account a reasonable range of environmental, economic, and technical factors, population and geographic areas, and specific sites. PRC §21159 further states that the Water Board is not required to engage in speculation or conjecture or conduct a project-level environmental analysis.

This section contains the environmental checklist for the proposed project (i.e., the proposed Basin Plan amendment), and includes the required analyses mentioned above. The explanation following the checklist provides details concerning the environmental impact assessment. Based on this analysis, Water Board staff concludes that adoption of the proposed Basin Plan amendment will not cause any significant adverse environmental impacts.

| | |
|---|---|
| ***1. PROJECT TITLE:*** | *GUADALUPE RIVER WATERSHED MERCURY TOTAL MAXIMUM DAILY LOAD BASIN PLAN AMENDMENT* |
| **2. Lead Agency Name and Address:** | California Regional Water Quality Control Board<br>San Francisco Bay Region<br>1515 Clay Street, Suite 1400<br>Oakland, California 94612 |
| **3. Contact Person and Phone Number:** | Carrie Austin<br>(510) 622-1015 |
| **4. Project Location:** | Guadalupe River Watershed<br>Santa Clara County, California |
| **5. Project Sponsor's Name and Address:** | California Regional Water Quality Control Board,<br>San Francisco Bay Region<br>1515 Clay Street, Suite 1400<br>Oakland, California 94612 |
| **6. General Plan Designation:** | Not Applicable |
| **7. Zoning:** | Not Applicable |

**8. Description of Project:**

The proposed project is a Basin Plan amendment to establish fish tissue water quality objectives and Total Maximum Daily Loads (TMDLs) for mercury in certain waters of the Guadalupe River Watershed (see Section 1) and an implementation plan to achieve the TMDLs. The goal of the Basin Plan amendment is to improve environmental conditions by addressing mercury pollution in the Guadalupe River watershed and San Francisco Bay and to reduce mercury fish tissue concentrations. The proposed amendment includes targets for small prey fish tissue methylmercury concentrations, and establishes allocations for mercury in sediment and methylmercury in the water column necessary to attain the targets. The implementation plan requires actions to attain the targets and allocations for mercury and methylmercury.

The project objectives are provided in Section 2.2, including "attain TMDL targets in as short a time as is feasible, and no longer than 20 years." To achieve these project objectives, the proposed Basin Plan amendment contains mercury allocations by source category (see Key Points in Section 8), and a sequence of implementation actions (see Implementation

Sequence in Section 9). As the Water Board is limited in prescribing the manner of compliance with state law requirements, the Basin Plan amendment does not prescribe specific projects through which dischargers and discharge categories are to meet the allocations.

While the Water Board would not directly undertake any actions that could physically change the environment, adoption of the proposed Basin Plan amendment will result in future actions by landowners, municipalities, and other agencies. Some compliance actions may result in physical changes to the environment. The environmental impacts of such changes are evaluated below, to the extent that they are reasonably foreseeable. Changes that are speculative in nature are difficult to analyze and, under CEQA, do not require environmental review.

Until the parties that must comply with requirements derived from the Basin Plan amendment propose specific projects, many physical changes cannot be anticipated. That said, it is reasonably foreseeable that the following activities may take place to comply with the Basin Plan amendment: (1) earthmoving , (2) recontouring and revegetation, (3) removal and disposal of mining waste, (4) stream bed and bank stabilization; and (5) installation and operation of reservoir oxygenation equipment. Although these activities are reasonably foreseeable methods of compliance, the implementation plan does not specify the nature of these actions. Therefore, this analysis considers these actions in general terms. Possible implementation actions are listed in Tables 9.1–9.3 (Section 9) and summarized below.

#### REASONABLY FORESEEABLE MEANS OF COMPLIANCE

- ***Earthmoving operations***. Approval of the Basin Plan amendment will result in earthmoving to clean up mining waste from historic mine sites and creeks and rivers downstream of the mines. For example, earthmoving to isolate mining waste from stormwater runoff and from creek channels may involve re-contouring hillslopes, terracing steep slopes and banks to reduce erosion rates, installation of erosion control materials, and replanting. All of these changes will be of short duration.
- ***Stream bed, bank and floodplain stabilization.*** Approval of the Basin Plan amendment will result in increased efforts to decrease erosion of stream bed and banks downstream of the mines that contain mercury laden sediments. These projects are likely to consist of erosion control and stabilization through bioengineering methods which primarily rely on plants, but which may also involve sediment removal, recontouring, and terracing, slope stabilization and replanting. Any such activities will also be of short duration.
- ***Removal and disposal of mining waste.*** The Basin Plan amendment will result in clean up of mining waste at historic mine sites such as the New Almaden Mining District, and the Santa Teresa, Bernal, and Hillsdale mines. Activities could include earthmoving operations, re-contouring, and erosion control actions similar to what are described above. Again, any such activities will be of short duration.
- ***Installation and operation of reservoir and lake oxygenation equipment.*** The Santa Clara Valley Water District is developing innovative technology to reduce methylation in reservoirs. The District's is currently piloting several prototype mechanisms in Guadalupe and Almaden reservoirs and Lake Almaden. These prototypes, which are visible above the surface of the water and about the size of small boats, are existing conditions and therefore not subject to this analysis. Full deployment in all reservoirs

throughout the watershed is speculative at this time and therefore is not considered in the present analysis.

These examples of reasonable means of compliance are not intended to be exhaustive or exclusive. Several conceivable actions that could be taken as a result of the Basin Plan amendment require speculation, and therefore cannot be evaluated. For example, actual outcomes and specific actions resulting from technical studies that are yet to be completed are too speculative to determine at this time.

9. **Surrounding Land Uses and Setting:**
***Setting:*** The Basin Plan amendment affects portions of the Guadalupe watershed influenced by historic mercury mining activities. Implementation involves specific land and water management actions in mercury mine areas, in reservoirs and other impoundments, and in creeks and rivers downstream of the mines.

***Land use:*** The upper portion of the watershed includes historic mercury mines, open space, and rural land uses. In the lower portion of the watershed, the Guadalupe River flows through the City of San Jose, the largest city in the Bay Area, where land uses include residential, commercial, and industrial uses.

10. **Other public agencies whose approval is required** (e.g., permits, financing approval, or participation agreement.)
The State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan amendment.

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **I. AESTHETICS -- Would the project:** | | | | |
| a) Have a substantial adverse effect on a scenic vista? | ☐ | ☐ | ☒ | ☐ |
| b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway? | ☐ | ☐ | ☐ | ☒ |
| c) Substantially degrade the existing visual character or quality of the site and its surroundings? | ☐ | ☐ | ☒ | ☐ |
| d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area? | ☐ | ☐ | ☐ | ☒ |
| **II. AGRICULTURE RESOURCES --** In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **Would the project:** | | | | |
| a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use? | ☐ | ☐ | ☐ | ☒ |
| b) Conflict with existing zoning for agricultural use, or a Williamson Act contract? | ☐ | ☐ | ☐ | ☒ |
| c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use? | ☐ | ☐ | ☐ | ☒ |

| ENVIRONMENTAL IMPACTS: *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **III. AIR QUALITY --** Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. **Would the project:** | | | | |
| a) Conflict with or obstruct implementation of the applicable air quality plan? | ☐ | ☐ | ☐ | ☒ |
| b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation? | ☐ | ☐ | ☒ | ☐ |
| c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)? | ☐ | ☐ | ☐ | ☒ |
| d) Expose sensitive receptors to substantial pollutant concentrations? | ☐ | ☐ | ☒ | ☐ |
| e) Create objectionable odors affecting a substantial number of people? | ☐ | ☐ | ☐ | ☒ |
| **IV. BIOLOGICAL RESOURCES -- Would the project:** | | | | |
| a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? | ☐ | ☒ | ☐ | ☐ |
| b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the | | | | |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| California Department of Fish and Game or U.S. Fish and Wildlife Service? | ☐ | ☒ | ☐ | ☐ |
| c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means? | ☐ | ☒ | ☐ | ☐ |
| d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites? | ☐ | ☐ | ☒ | ☐ |
| e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance? | ☐ | ☐ | ☐ | ☒ |
| f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan? | ☐ | ☐ | ☐ | ☒ |
| **V. CULTURAL RESOURCES -- Would the project:** | | | | |
| a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5? | ☐ | ☐ | ☒ | ☐ |
| b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5? | ☐ | ☐ | ☒ | ☐ |
| c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature? | ☐ | ☐ | ☐ | ☒ |
| d) Disturb any human remains, including those interred outside of formal cemeteries? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **VI. GEOLOGY AND SOILS -- Would the project:** | | | | |
| a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: | | | | |
| i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42. | ☐ | ☐ | ☐ | ☒ |
| ii) Strong seismic ground shaking? | ☐ | ☐ | ☐ | ☒ |
| iii) Seismic-related ground failure, including liquefaction? | ☐ | ☐ | ☐ | ☒ |
| iv) Landslides? | ☐ | ☐ | ☐ | ☒ |
| b) Result in substantial soil erosion or the loss of topsoil? | ☐ | ☒ | ☐ | ☐ |
| c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse? | ☐ | ☒ | ☐ | ☐ |
| d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property? | ☐ | ☐ | ☐ | ☒ |
| e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **VII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:** | | | | |
| a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials? | ☐ | ☐ | ☒ | ☐ |
| b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment? | ☐ | ☐ | ☒ | ☐ |
| c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school? | ☐ | ☐ | ☐ | ☒ |
| d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code § 65962.5 and, as a result, would it create a significant hazard to the public or the environment? | ☐ | ☒ | ☐ | ☐ |
| e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area? | ☐ | ☐ | ☐ | ☒ |
| f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area? | ☐ | ☐ | ☐ | ☒ |
| g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan? | ☐ | ☐ | ☐ | ☒ |
| h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **VIII. HYDROLOGY AND WATER QUALITY -- Would the project:** | | | | |
| a) Violate any water quality standards or waste discharge requirements? | ☐ | ☐ | ☐ | ☒ |
| b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)? | ☐ | ☐ | ☐ | ☒ |
| c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion of siltation on- or off-site? | ☐ | ☒ | ☐ | ☐ |
| d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site? | ☐ | ☐ | ☒ | ☐ |
| e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff? | ☐ | ☐ | ☐ | ☒ |
| f) Otherwise substantially degrade water quality? | ☐ | ☐ | ☐ | ☒ |
| g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows? | ☐ | ☐ | ☐ | ☒ |
| i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam? | ☐ | ☐ | ☐ | ☒ |
| j) Inundation of seiche, tsunami, or mudflow? | ☐ | ☐ | ☐ | ☒ |
| **IX. LAND USE AND PLANNING -- Would the project:** | | | | |
| a) Physically divide an established community? | ☐ | ☐ | ☐ | ☒ |
| b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect? | ☐ | ☐ | ☐ | ☒ |
| c) Conflict with any applicable habitat conservation plan or natural community conservation plan? | ☐ | ☐ | ☐ | ☒ |
| **X. MINERAL RESOURCES -- Would the project:** | | | | |
| a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state? | ☐ | ☐ | ☐ | ☒ |
| b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| **XI. NOISE -- Would the project result in:** | | | | |
| a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies? | ☐ | ☐ | ☒ | ☐ |
| b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels? | ☐ | ☐ | ☒ | ☐ |
| c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project? | ☐ | ☐ | ☐ | ☒ |
| d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project? | ☐ | ☐ | ☒ | ☐ |
| e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels? | ☐ | ☐ | ☐ | ☒ |
| f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels? | ☐ | ☐ | ☐ | ☒ |
| **XII. POPULATION AND HOUSING -- Would the project:** | | | | |
| a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)? | ☐ | ☐ | ☐ | ☒ |
| b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere? | ☐ | ☐ | ☐ | ☒ |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| c) Displace substantial numbers of people necessitating the construction of replacement housing elsewhere? | ☐ | ☐ | ☐ | ☒ |
| **XIII. PUBLIC SERVICES --** | | | | |
| a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services: | | | | |
| Fire protection? | ☐ | ☐ | ☐ | ☒ |
| Police protection? | ☐ | ☐ | ☐ | ☒ |
| Schools? | ☐ | ☐ | ☐ | ☒ |
| Parks? | ☐ | ☐ | ☐ | ☒ |
| Other public facilities? | ☐ | ☐ | ☐ | ☒ |
| **XIV. RECREATION --** | | | | |
| a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated? | ☐ | ☐ | ☒ | ☐ |
| b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment? | ☐ | ☐ | ☒ | ☐ |
| **XV. TRANSPORTATION / TRAFFIC -- Would the project:** | | | | |
| a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to- | | | | |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| capacity ratio on roads, or congestion at intersections)? | ☐ | ☐ | ☒ | ☐ |
| b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways? | ☐ | ☐ | ☒ | ☐ |
| c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks? | ☐ | ☐ | ☒ | ☐ |
| d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? | ☐ | ☐ | ☐ | ☒ |
| e) Result in inadequate emergency access? | ☐ | ☐ | ☐ | ☒ |
| f) Result in inadequate parking capacity? | ☐ | ☐ | ☐ | ☒ |
| g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)? | ☐ | ☐ | ☐ | ☒ |
| **XVI. UTILITIES AND SERVICE SYSTEMS -- Would the project:** | | | | |
| a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board? | ☐ | ☐ | ☐ | ☒ |
| b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | ☐ | ☐ | ☐ | ☒ |
| c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? | ☐ | ☐ | ☒ | ☐ |
| d) Have sufficient water supplies available to serve the project from existing entitlements | | | | |

ENVIRONMENTAL IMPACTS:

| *Issues:* | *Potentially Significant Impact* | *Less Than Significant With Mitigation Incorporation* | *Less Than Significant Impact* | *No Impact* |
|---|---|---|---|---|
| and resources, or are new or expanded entitlements needed? | ☐ | ☐ | ☐ | ☒ |
| e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments? | ☐ | ☐ | ☐ | ☒ |
| f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs? | ☐ | ☐ | ☐ | ☒ |
| g) Comply with federal, state, and local statutes and regulations related to solid waste? | ☐ | ☐ | ☐ | ☒ |

**XVII. MANDATORY FINDINGS OF SIGNIFICANCE**

| | | | | |
|---|---|---|---|---|
| a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory? | ☐ | ☐ | ☒ | ☐ |
| b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)? | ☐ | ☐ | ☐ | ☒ |
| c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly? | ☐ | ☐ | ☐ | ☒ |

#### *10.4.2 EXPLANATIONS*

The proposed Basin Plan amendment does not define the specific actions that responsible parties would take to comply with requirements derived from the Basin Plan amendment. As discussed above, some physical changes resulting from the Basin Plan amendment are foreseeable, but will be of short duration. These include changes related to mining waste cleanup and creek and river bank, bed, and floodplain stabilization and restoration. However, details of the method of cleanup, extent of excavation, and waste disposal methods are not known at this time.

Following adoption of these TMDLs, responsible parties will be required to develop implementation projects. These projects will be subject to cleanup and abatement orders issued by the Water Board. Specific implementation projects, when they are developed, will be subject to review and/or approval by the Water Board, which will, as part of administering its program responsibilities, likely either disapprove projects with significant and unacceptable environmental impacts (e.g., instream work with too many impacts) or require implementation of routine mitigation measures (e.g., erosion control and construction best management practices) to ensure that environmental impacts remain at, or are reduced to, less-than-significant levels. Additionally, existing local and state agency performance standards (e.g., air standards, noise ordinances, and provisions of the Santa Clara County grading ordinance) will apply, and shall keep impacts at less-than-significant levels.

For these reasons, this analysis considers the above-mentioned reasonably foreseeable methods of compliance with the Basin Plan amendment in general terms and concludes that the Basin Plan amendment will not have environmental impacts. An explanation for each box checked on the environmental checklist is provided below.

*I. Aesthetics*

a) The project will result in physical changes to the landscape of the New Almaden Mining District, Santa Teresa, Bernal and Hillsdale mines, and the surrounding landscape. Reasonably foreseeable changes may include altered topography, slope terracing, exposure of soils during grading and construction, and long-term changes in vegetation. These changes may be noticeable to park workers and visitors. However, given that the mine sites have been extensively altered and modified by mining, coupled with the subtle nature of the changes, impacts to scenic vistas will be minimal. Replanting and monitoring will be required for all mining waste cleanup projects. Growth of new vegetation will lessen the impact of visual changes in the landscape. Therefore, visual impacts on scenic vistas will be less than significant.

   Actions and projects that could result from the Basin Plan amendment may also cause temporary changes to the visual quality of creeks and the river. These changes to the aesthetic environment will be small in scale and will not result in significant long-term visual impacts.

b) The only state scenic highway in Santa Clara County is Highway 9. This highway is located outside the Guadalupe River watershed and will not be affected by this Basin Plan amendment.

c) Potential changes to the visual character of the landscape that could result from the Basin Plan amendment are described in response to question I(a) above. Long term changes in the existing visual character or quality of the mine sites, creeks and surrounding areas will be less than significant.

Technology under development by the Santa Clara Valley Water District to reduce methylation in reservoirs may alter the visual character of the reservoirs. Prototypes now being tested, which are visible above the surface of the water and about the size of a small boat, are existing conditions and therefore not subject to this analysis. The reservoirs where they are located (Almaden and Guadalupe reservoirs, and Lake Almaden) are in unpopulated areas high in the watershed. Future deployment of more or different mechanisms is speculative and beyond the scope of this Basin Plan amendment project.

Therefore we maintain that the Basin Plan amendment will not degrade the existing visual character or quality of the site or its surroundings to any significant extent.

d) Actions and projects that could result from the Basin Plan amendment will not include new lighting or installation of large structures that could generate reflected sunlight or glare. The Basin Plan amendment will not result in adverse light and glare impacts.

*II. Agriculture Resources*

a) Adoption of the Basin Plan amendment will affect historic mine areas and creeks and rivers in rural and urban areas. It will not affect agricultural land and therefore will not convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance to non-agricultural uses and no impact to these resources will occur.

b) The Basin Plan amendment will not affect existing agricultural zoning or any aspects of Williamson Act contract and will not have any adverse impact in this regard.

c) Adoption of the Basin Plan amendment will not affect agricultural land and will not result in conversion of land to non-agricultural uses. Therefore, no impact could occur.

*III. Air Quality*

a) Because the Basin Plan amendment will not cause any significant changes in population or employment, it will not generate ongoing traffic-related emissions. It will also not involve the construction of any permanent emissions sources. For these reasons, no permanent change in air emissions will occur, and the Basin Plan amendment will not conflict with or obstruct implementation of any applicable air quality plans.

b) Air emissions that could result from the Basin Plan amendment would be related to grading (dust and vehicle exhaust) associated with mining waste management, cleanup, or removal. Fine particulate matter (PM10) is the pollutant of greatest concern with respect to construction. PM10 emissions can result from a variety of construction activities, including excavation, grading, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. Temporary emissions of carbon monoxide, ozone precursors, and other vehicle exhaust byproducts would also be generated from heavy construction equipment.

The Guadalupe River Watershed is within the jurisdiction of the Bay Area Air Quality Management District (BAAQMD). The BAAQMD CEQA Guidelines (1996) recommend that an analysis of air quality impacts associated with construction activities emphasize implementation of effective and comprehensive control measures, rather than detailed quantification of emissions. Therefore, future construction-related emissions from equipment and trucks hauling materials to and from cleanup sites are not quantified here. Although grading activities result in emission of carbon monoxide and ozone precursors, "these emissions are included in the emissions inventory that is the basis for regional air quality plans, and are not expected to impede attainment or maintenance of ozone or carbon monoxide standards in the Bay Area" (BAAQMD 1996). Therefore, while the Basin Plan amendment could result in a temporary increase in criteria pollutants, it will not violate any air quality standard or contribute substantially to an existing or projected air quality violation. Although we find this impact to be less than significant,, the following mitigation measures will be included in cleanup and abatement orders issued by the Water Board.

Mitigation Measure AIR-1: Comply with BAAQMD Control Measures contained in Table 2 of the 1996 BAAQMD CEQA Guidelines.

1. Water all construction areas as needed to minimize and control dust
2. Cover all trucks hauling soil and other loose materials or require all trucks to maintain at least 2 feet of freeboard (the space between the top of the load and the top of the truck bed)
3. Apply water as needed, or apply non-toxic soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites
4. Sweep (with water sweepers) all paved access roads, parking areas, staging areas, and adjacent public streets if soil material is visible
5. Hydroseed or apply non-toxic soil stabilizers to inactive constriction areas (previously graded areas inactive for ten days or more)
6. Enclose, cover, water, or apply non-toxic soil stabilizers to exposed stockpiles of material that can generate dust.
7. Limit traffic speed on unpaved roads to 15 mph
8. Use Best Available Technology to reduce emissions from construction equipment

c) Because the Basin Plan amendment will not generate ongoing traffic-related emissions or involve the construction of any permanent emissions sources, it will not result in a cumulatively considerable net increase of any pollutant for which the project region is non-attainment and no air quality impact will result.

d) The Basin Plan amendment could result in earthmoving activities in Almaden Quicksilver County Park (and at other mine sites) that could generate dust. As mentioned above, Mitigation Measure AIR-1 will be imposed on cleanup orders issued by the Water Board. No hospitals, day care facilities, or schools are located in the immediate vicinity of mining waste cleanup sites and these sensitive receptors will not be adversely affected. Santa Clara County Parks will close all construction areas to park visitors during mining waste cleanup to prevent hikers and bike riders from being exposed to potential impacts from air born dust. Therefore, impacts will be less than significant.

e) The Basin Plan amendment will result in mining waste clean up and creek and river bank stabilization, but these activities are not expected to create objectionable odors, therefore, no odor impacts will result.

*IV. Biological Resources*

As stated in Section 5 of this Staff Report, wildlife most likely at risk from methylmercury in the aquatic environment are terrestrial species that primarily or exclusively consume fish in which methylmercury has bioaccumulated. State or federally listed threatened or endangered wildlife species that may be resident in the watershed include red-legged frog, yellow-legged frog, western pond turtle, southwestern pond turtle, Central California coast steelhead, native rainbow trout, Chinook salmon, California least tern, tri-colored blackbird, yellow warbler, double-crested cormorant, and bald eagle, as well as the Bay checkerspot butterfly (Santa Clara Valley Water District 2005). The red-legged frog, steelhead, and tern are all federally listed and therefore protected by the Endangered Species Act (ESA). The bald eagle has been delisted; however it is still protected by the federal Migratory Bird Treaty Act and the federal Bald and Golden Eagle Protection Act. Although the fall-run Chinook salmon is not listed; it is regulated by NOAA Fisheries under the Magnuson-Stevens Fishery Conservation and Management Act.

Plant species of concern include Mt. Hamilton thistle, Santa Clara Valley dudleya, Santa Clara red ribbons, most beautiful jewel flower, smooth lessingia, fragrant frittilary, and robust spineflower (*ibid*).

Furthermore, upland areas of the watershed contain serpentine soils, home to sensitive plant and insect communities.

The ESA protects federally listed plants and wildlife. ESA Section 9 prohibits the taking of endangered wildlife, where taking is defined as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in such conduct” (50 CFR 17.3). This statute governs removing, cutting, digging up, damaging or destroying any endangered plant on non-federal land in knowing violation of state law (16 USC 1538). ESA Section 10 provides for issuance of incidental take permits to non-federal agencies provided a habitat conservation plan is in place.

While the Basin Plan amendment is designed to benefit, enhance, restore, and protect biological resources, including fish, wildlife, and rare and endangered species, it is possible that specific mining waste cleanup or creek stabilization projects involving earthmoving activities and landscape modifications could affect sensitive or special status species, either directly or through habitat modifications. However, these impacts will be mitigated to less than significant levels through adherence to the conditions, specifications, and requirements of the ESA; through avoidance of sensitive resources; and/or through the permitting actions described below.

a) Mine site cleanup will be directed under Water Board orders. All such orders will require detailed workplans and site engineering plans, prepared by licensed professionals. Based on the presence or potential presence of threatened and/or endangered species and migratory birds, future projects will be required to comply with the requirements of the Endangered Species Act (16 USC Section 1536(a) and (h)(1)(B), and Section 1538(a); and 16 USC Section 662); the Migratory Bird Treaty of 1972 ( 16 USC Section 703–711); and the Rivers and Harbors Act of 1899 (33 USC Section 403) in taking action to prevent the loss of or damage to fish and wildlife.

   Permitting agencies required to approve and set conditions for projects that may affect species of concern include, for projects within stream channels, The U.S. Army Corps of Engineers (under Nationwide Permits 27 and 38, provisions 2, 3, 4, and 17(a)–(e)), U.S. Fish and Wildlife Service (enforcing the federal Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act), the National Oceanic and Atmospheric Administration/National Marine Fisheries Service (enforcing the Magnuson-Stevens Fishery Conservation and Management Act).

   For projects on land, the state Department of Fish and Game is prohibited by Fish and Game Code Section 3505 from authorizing the incidental take of raptors, their nests, or eggs. Furthermore, all projects requiring a grading permit from Santa Clara County, including projects “where the proposed grading work consists of cut and/or fill each of which is 500 cubic yards or less in volume and the use associated with the proposed grading does not require or has already received a land use approval (e.g., building site approval)” (SCC 2001, Section C12-429.1), “shall be processed in accordance with the California Environmental Quality Act (CEQA), and regulations promulgated thereunder” (*ibid*., Section C12-430). Compliance with CEQA assures that all species of concern will be protected and unavoidable impacts will be mitigated. Required management measures will reduce impacts to special status species, sensitive natural communities, and rare serpentine soil habitat so that no significant impacts occur. Such actions include, but are not limited to, requiring pre-construction surveys for the presence of special status species; restrictions on construction during sensitive periods of time; employment of biologists on-site to oversee work; avoidance of construction in known sensitive habitat areas or relocation of animals, and construction buffers and setbacks.

b) Activities required by the Basin Plan amendment to remove mining waste residue from stream channels could have local adverse impacts on riparian habitat. Disturbance of soil from the removal of mining waste, re-contouring stream banks, and placement of reinforcement materials (rip-rap, large wood, or other materials) could affect sensitive riparian habitat.

The Santa Clara County Grading Ordinance, Section C12-477.1, "Environmental protection," states that "The property owner and the person(s) doing or causing or directing the grading are responsible for protecting environmentally sensitive areas on or near the site, such as creeks, streams, wetlands, lakes, springs, trees, and riparian habitat that could be affected by the grading. The grading shall be conducted in a manner which minimizes and mitigates environmental damage." (SCC 2001)

In addition, pursuant to permit conditions and the Water Board's Order R2-2002-0028, *Waste Discharge Requirements and Water Quality Certification for Santa Clara Valley Water District, Multi-Year Stream Maintenance Program, Santa Clara County*, potential impacts to sensitive riparian habitat from the Water District's stream maintenance activities will be kept to a less than significant level or mitigated to minimize impacts to riparian areas and other sensitive natural communities. Actions to protect these communities may include, but will not be limited to, requiring pre-construction habitat surveys including wetland delineation; employment of biologists on-site to oversee work; avoidance of construction in known sensitive habitat areas, restrictions on construction during sensitive periods of time; and construction buffers and setbacks.

For future work in defined creek channels between banks, the Water Board, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service must ensure, in the course of their permitting and approval processes, that there are no potential adverse effects on riparian habitat and sensitive natural communities. Outside creek banks and adjacent to the channel, the health and quality of riparian habitat directly influences beneficial uses, and shall be protected by the Water Board as it exercises its mandate to protect beneficial uses including rare and endangered species and wildlife habitat.

At a minimum, Basin Plan amendment projects must comply with standard permit conditions in the U.S. Army Corps of Engineers' Nationwide Permits nos. 13 (Bank Stabilization) and 27 (Stream and Wetland Restoration Activities). USACE final approval and issuance of a permit is only valid with CWA 401 certification of the proposed activity, which is made by the Water Board. Section 401 certifications often include conditions that are more stringent than the federal requirements. Federal requirements include, for example, nationwide permit condition 20, which states that "for losses of streams or other open waters…the district engineer may require compensatory mitigation, such as stream restoration, to ensure that the activity results in minimal adverse effects on the aquatic environment."

Furthermore, provisions of the Santa Clara Valley Water District's stream maintenance permit require that the District mitigate temporary impacts to beneficial uses caused by stream maintenance or vegetation management activities. Beneficial uses in this watershed include wildlife habitat, protection of threatened and endangered species, and fish spawning habitat. City and county tree ordinances also apply.

Given the scope of required permitting processes and the nature of standard conditions imposed for such activities, we assert that any adverse effect on any riparian habitat or other sensitive natural community in the Guadalupe River watershed associated with the Basin Plan amendment will not be substantial, or will be mitigated to a less than significant level.

c) Implementation actions required for compliance with the Basin Plan amendment may include grading and erosion control measures that could alter federally protected wetlands, particularly in downstream reaches of the mine area, in creek channels. At a minimum, projects must comply with standard permit conditions in the U.S. Army Corps of Engineers' Nationwide Permits nos. 13 (Bank Stabilization) and 27 (Stream and Wetland Restoration Activities). USACE final approval and issuance of a permit is only valid with CWA 401 certification of the proposed activity, which is made by the Water Board. Section 401 certifications often include conditions that are more stringent than the federal requirements. Federal requirements include, for example, standard measures to minimize soil disturbance in wetlands (Provision 11) and prohibit discharge of dredged or fill material into waters of the United States (Provision 19).

Bank stabilization measures could result in minor and in many cases, temporary alteration of wetlands in creeks and rivers. These impacts, however, will not be substantial in scale or duration.

Actions described in IV(b) above, which the Water Board routinely requires and which are enumerated in Order R2-2002-0028 along with mitigation and monitoring requirements, will keep impacts to less-than-significant levels.

d) The Basin Plan amendment will not substantially interfere with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. Projects could be proposed to comply with the Basin Plan amendment that involve construction or earthmoving activities will be localized at specific mine sites and in discrete stream channel segments and are unlikely to interfere with wildlife movement, migratory corridors, or nurseries. Therefore, impacts to migratory corridors for fish and wildlife will be less-than-significant.

e) The Basin Plan amendment itself does not conflict with any local policies or ordinances protecting biological resources such as trees. The hillslope and stream bank stabilization goals of the Basin Plan amendment promote retention of mature trees and replanting of native riparian vegetation and do not conflict with local policies or ordinances. Permits for local projects proposed to comply with Basin Plan amendment will require replanting with native species, including native riparian trees, to enhance stream bank stabilization.

f) The Basin Plan amendment does not conflict with any adopted Habitat Conservation Plan (HCP), Natural Community Plan (NCP), or other approved local, regional or state habitat conservation plan. Santa Clara County is developing a HCP/NCP for the Santa Clara Valley but it is not yet approved. The Santa Clara Valley Water District is developing an HCP for the Guadalupe, Stevens and Coyote creek watersheds which is also not yet approved. These

HCPs are intended to protect habitat for endangered species and are consistent with the TMDL project goal of reducing mercury concentrations in sediment, water, and fish tissue while minimizing impacts on the environment. Future projects proposed to comply with Basin Plan amendment requirements after approval of these HCPs will be subject to local agency review to ensure no conflict with local polices.

*V. Cultural Resources*

a) Projects involving earthmoving or construction to comply with requirements of the proposed Basin Plan amendment are reasonably foreseeable. Earthmoving will occur at historic mine sites, on old mining roads, and along creek channels. Construction on a small to moderate scale would occur in Almaden Quicksilver County Park in the vicinity of historic mining structures and features such as mine shafts or remains of equipment or foundations, and could affect areas containing historical resources. The New Almaden Mining District is a Registered National Historic Landmark because of the important contributions to U.S. history made by this mining community. The following will reduce impacts to less than significant levels.

- County General Plan policies C-RC49 and C-RC50 require that parties undertaking cleanup (Santa Clara County Parks Department and other property owners) shall:
  - Inventory and evaluate heritage resources
  - Prevent or minimize adverse impacts on heritage resources
  - Restore, enhance, and commemorate resources as appropriate
- County Code and Municipal Code (1998) Division C17 Historic Preservation requires property owners to take all reasonable measures to avoid or minimize harm to the discovered resource until a qualified historian assesses the discovery. Under this ordinance, if previously unidentified historic or other cultural resources are discovered during mining waste cleanup activities, grading and other activities in the immediate vicinity of the discovery shall be halted until the historian arrives. Compliance with this ordinance by a property owner and its contractors minimizes the potential for a project to directly or indirectly destroy a unique historical or other cultural resource.

Therefore the Basin Plan amendment will not cause any substantial adverse change in the significance of a historical resource, as defined in the CEQA Guidelines §15064.5.

b) Projects involving earthmoving or construction to comply with requirements of the proposed Basin Plan amendment are reasonably foreseeable. Excavation, processing and transportation of ore at old mine sites has likely destroyed existing archeological remains that pre-date mining activities. It is unlikely that Basin Plan-related projects will have significant adverse impacts in these areas. Basin Plan-related earthmoving would occur along creek channels and would be small in scale. Nonetheless, these activities could impact significant unique archeological resources defined by §15064.5 of the CEQA Guidelines. The following will reduce these impacts to less than significant levels.

- County General Plan policies C-RC 49 and C-RC 50 will reduce impacts to potentially unique archeological resources if they are found along creek channels proposed for cleanup. The policies state:

  > **C-RC 49:** Cultural heritage resources within Santa Clara County should be preserved, restored wherever possible, and commemorated as appropriate for their scientific, cultural, historic and place values.
  >
  > **C-RC 50:** Countywide, the general approach to heritage resource protection should include the following strategies:
  >
  > 1. Inventory and evaluate heritage resources
  > 2. Prevent or minimize adverse impacts on heritage resources
  > 3. Restore, enhance, and commemorate resources as appropriate (SCC 2004)

  Pursuant to these policies, if previously unidentified archeological resources are discovered during mining waste cleanup activities, grading and other activities in the immediate vicinity of the discovery shall be halted and the property owner will be required by Santa Clara County to take all reasonable measures to avoid or minimize harm to the discovered resource until a qualified archeologist can assess the discovery. Such actions by the property owner and their contractors will minimize the potential for the project to directly or indirectly destroy a unique archeological resource.

- According to the California Health and Safety Code, six or more human burials at one location constitute a cemetery (§ 8100). Disturbance of a Native American cemetery is a felony (§ 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 consult with the California Native American Heritage Commission.

- Public Resources Code § 5097.5(a) prohibits excavating, removing, destroying, injuring, or defacing any archeological resource ("historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, rock art, or any other archaeological, paleontological or historical feature, situated on public lands" such as land owned by Santa Clara County or within the jurisdiction of the Santa Clara Valley Water District). If an archaeological resource must be removed in order to complete cleanup, the property owner will be required to consult with appropriate Native American groups identified by the Native American Heritage Commission. (PRC § 5097.9)

- Lead agencies for all projects must comply with CEQA provisions related to archaeological resources (PRC § 21083.2; CEQA Guidelines §15064.5 et seq. The Guidelines cite curation of archaeological artifacts as mitigation for unavoidable removal of cultural resources from the project site.

Therefore we assert that the Basin Plan amendment will not cause any substantial adverse change in the significance of a unique archaeological resource pursuant to CEQA Guidelines §15064.5.

c) Projects involving earthmoving or construction to comply with requirements of the proposed Basin Plan amendment are reasonably foreseeable. However, construction will be confined to extensively altered mining areas where extensive geologic data indicates that no known paleontological resource (i.e., fossils, etc.) or unique geologic features occur. Therefore the Basin Plan amendment will not directly or indirectly destroy a unique paleontological resource or site, or unique geological feature..

d) Projects involving earthmoving or construction to comply with requirements of the proposed Basin Plan amendment are reasonably foreseeable. Construction will be confined to areas that have been extensively disturbed by historic mining activities, and earthmoving would likely occur in areas already disturbed by recent human activity—not at or in areas likely to contain human remains or cemeteries. Therefore, the Basin Plan amendment will not disturb human remains, including those interred outside of formal cemeteries.

*VI. Geology and Soils*

a) The Basin Plan amendment will not involve the construction of habitable structures; therefore, it will not result in any human safety risks related to fault rupture, seismic ground-shaking, ground failure, or landslides.

b) Specific projects involving earthmoving or construction activities to comply with requirements of the Basin Plan amendment are reasonably foreseeable. Such activities will not result in substantial soil erosion or loss of topsoil. The purpose of the Basin Plan amendment is to control and reduce erosion, not increase it.

Temporary earthmoving operations could result in short-term, limited erosion. However, mine area cleanup operations will be carried out under Water Board order, and lead agencies will incorporate rigorous erosion control measures. Future compliance projects that take place within a defined creek channel and between banks will be subject to, at a minimum, standard permit conditions in the U.S. Army Corps of Engineers' Nationwide Permits nos. 13 (Bank Stabilization) and 27 (Stream and Wetland Restoration Activities). USACE final approval and issuance of a permit is only valid with CWA 401 certification of the proposed activity, which is made by the Water Board. Section 401 certifications often include conditions that are more stringent than the federal requirements. Federal requirements include, for example, implementation of effective construction site management and erosion control best management practices.

Dischargers whose projects disturb 1 or more acres of soil or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, 99-08-DWQ). Construction activity subject to this permit includes clearing, grading and disturbances to the ground such as stockpiling, or excavation.

The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP should contain a site map(s) that shows the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography both before and after construction, and drainage patterns across the project. The SWPPP must list the Best Management Practices (BMPs) the discharger will use to control storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment.

In addition, the Water Board's Order R2-2002-0028, *Waste Discharge Requirements and Water Quality Certification for Santa Clara Valley Water District, Multi-Year Stream Maintenance Program, Santa Clara County*, requires the District to incorporate effective erosion control measures, including bank stabilization and revegetation, in all of its maintenance projects in defined creek channels in Santa Clara County below 1,000 ft. elevation. Monitoring and annual reporting back to the Water Board is also required in the Order.

Finally, grading ordinances of the City of San José (City of San José Public Works Department 1992) and the County of Santa Clara (SCC 1981; SCC 2001, and SCC 2008c) require assessment of slope stability, expansive soils, and landslide protection, and mandate erosion control measures. All plans must be prepared by qualified, licensed professional engineers. Erosion control measures, including creek bank stabilization projects, must be reviewed and/or permitted by the Water Board, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, California Dept. of Fish and Game, and the Santa Clara Valley Water District.

Based on all of these overlapping permitting authorities and permit requirements, we assert that the Basin Plan amendment will not result in substantial soil erosion or loss of topsoil, and its impacts will be less-than-significant.

c) Because portions of the project are located in a seismically active area and the Basin Plan amendment includes actions intended to stabilize existing mining waste on unstable slopes and within steam banks, some construction is likely to occur in potentially unstable areas.

The County of Santa Clara revised the Geologic Hazards section of the County Code in 2002 (SCC 2002) to deal specifically with fault rupture hazard zones, landslide hazard zones, compressible soils hazard zones, and liquefaction hazard zones. This section applies to potentially unstable areas of the upper Guadalupe watershed. The County also makes available maps and data related to these seismic hazard zones (see http://www.sccgov.org/portal/site/planning/planningchp?path=%2Fv7%2FPlanning%2C%20Office%20of%20%28DEP%29%2FMaps%20%26%20GIS%2FGeologic%20Hazards%20Zones%28Maps%20%26%20Data%29 ).

Section C12-607 states that applications for any proposed work within a geologic hazard zone must be reviewed by the County Planning Office and/or the County Geologist. Grading permit requirements for the County of Santa Clara include progress reports and final certification of slope stability and soil bearing capacity; and a final soils report based on the "as-built" grading plan as affected by soils or geologic factors. (Section C.12-461; SCC 2001).

In addition, project plans for projects within a defined creek channel will be subject to standard permit conditions in the U.S. Army Corps of Engineers' Nationwide Permits nos. 13 (Bank Stabilization) and 27 (Stream and Wetland Restoration Activities). Future applicants will be required to ensure that earthmoving does not result in soil erosion, bank collapse, or land instability.

The Basin Plan amendment would not involve the construction of habitable structures, and any construction would be relatively small in scale. In view of all of the above required permit actions and associated geologic hazard assessments and regulatory oversight, the Basin Plan amendment will not involve activities that could create or trigger landslides, lateral spreading, subsidence, liquefaction, or collapse, and its impacts will therefore be less-than-significant, and not create safety or property risks due to unstable or expansive soils.

d) The Basin Plan amendment will not involve construction of buildings or any habitable structures. Minor grading and construction could occur in areas with expansive soils but this activity would not create a substantial risk to life or property.

Furthermore, the County of Santa Clara's grading ordinance (Section C12-491; SCC 2001) requires removal and replacement of expansive soils if found within two feet of finished lot grade in a building location, or other measures as required by a building official based on a report by a registered civil engineer.

Therefore, the Basin Plan amendment will not result in impacts related to expansive soils.

e) The Basin Plan amendment will not require wastewater disposal systems; therefore, affected soils need not be capable of supporting the use of septic tanks or alternative wastewater disposal systems. No impacts from septic tanks or alternative wastewater disposal systems will result from the project.

*VII. Hazards and Hazardous Materials*

a) Actions to comply with the proposed Basin Plan amendment will involve handling and management of soil and sediment that could contain high concentrations of mercury. While the Water Board anticipates that most soil and sediment will be stabilized and/or isolated on site and in place, some mercury-contaminated material may require offsite disposal. In this event, soil and sediment will be stockpiled and segregated, characterized for disposal by chemical analytical testing as required by the permitted landfill facility, then manifested, transported, and disposed of in accordance with federal, state, and local regulations. Handling, transportation, and disposal of hazardous waste is regulated by the U.S. Environmental Protection Agency, the California Department of Toxic Substances Control, and locally by the Santa Clara County Hazardous Materials Compliance Division. California's criteria for hazardous waste are more stringent than federal criteria. Compliance with all applicable laws and regulations will reduce potential impacts from handling and transport of potentially hazardous materials to a less-than-significant level.

b) Actions to comply with the Basin Plan amendment will include cleanup of mine waste as described in the Project Description, above. Construction will involve use of heavy equipment (operated by petroleum based fuels) to move mine waste (soil with high concentrations of mercury). Accidents will be avoided or minimized to less than significant levels through compliance with applicable federal, state, and local laws and regulations pertaining to grading; hazardous materials handling and transport; and employee safety.

All contractors and subcontractors working on mining waste cleanup projects are required by state law to prepare and implement a site-specific health and safety plan. Activities that involve contact with high mercury concentration mining waste will be conducted by 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) trained personnel.

Therefore, the Basin Plan amendment will not create a significant hazard to the public, or to the environment, through reasonably foreseeable accidents that involve release of hazardous materials to the environment.

c) Basin Plan amendment-related grading and site cleanup will be located in historic mine areas of the New Almaden Mining District, Santa Teresa, Bernal and Hillsdale mines, and surrounding areas; and along stream channels in areas used as open space and for rural uses. None of these project locations are within one-quarter mile of an existing or proposed school site.

d) Almaden Quicksilver County Park, the site of historic mercury mining operations, is on California's "Cortese List," compiled pursuant to Government Code §65962.5. Basin Plan amendment implementation actions will occur on this site. However, work on this site should not create a significant hazard to the public, or to the environment. The Water Board regulates such listed hazardous material sites. Compliance projects will be subject to review and~~/or~~ approval of the Water Board, which ~~would~~ requires implementation of routine and standard erosion control best management practices, proper construction site management, health and safety plans, monitoring, reporting, and measures such as fencing, traffic controls, dust controls during construction. Thus compliance with Water Board orders will ensure that the Basin Plan amendment will not create a significant hazard to the public or the environment.

The U.S. Army Corps of Engineers Nationwide Permit 38, Cleanup of Hazardous and Toxic Waste, covers “specific activities required to effect the containment, stabilization, or removal of hazardous or toxic waste materials that are performed, ordered, or sponsored by a government agency” and requires the permittee to submit pre-construction notification to the district engineer before beginning work. Provisions in the Nationwide permit are entirely protective of public health and safety and the environment. .

e) The Basin Plan amendment does not include actions that will result in a safety hazard for people residing or working near a public airport or vicinity. No airports or air fields are located in the Guadalupe River watershed.

f) The Basin Plan amendment will not result in construction of buildings or other structures that could result in safety hazards for people residing or working near a private air strip.

g) Hazardous waste management activities resulting from the Basin Plan amendment will not interfere with any emergency response plans or emergency evacuation plans, and therefore no impacts will result.

h) The Basin Plan amendment will not affect the potential for wildland fires. Therefore people or structures will not be exposed to a significant risk of loss, injury, or death from wildland fire.

*VIII. Hydrology and Water Quality*

a) The project amends the Basin Plan, which articulates applicable water quality standards. Therefore, it will not violate standards or waste discharge requirements, and no adverse impacts to water quality will result.

b) The Basin Plan amendment will not deplete groundwater supplies or interfere with groundwater recharge. No adverse impacts to groundwater recharge will result.

c) Specific projects involving earthmoving or construction activities could affect existing drainage patterns in mine areas. Temporary earthmoving operations could result in short-term, limited erosion. Specific compliance projects would be subject to the review and~~/or~~ approval of the Water Board, which ~~would~~ requires implementation of routine and standard erosion control best management practices and proper construction site management. Changes to drainage networks will be localized and will be intended to isolate mining waste from surface water runoff and reduce overall erosion. As explained below, we do not foresee alteration of the course of a stream or river in a manner that would result in substantial soil erosion.

The Water Board's Order R2-2002-0028, *Waste Discharge Requirements and Water Quality Certification for Santa Clara Valley Water district, Multi-Year Stream Maintenance Program, Santa Clara County* sets conditions for alterations to streams or rivers in Santa Clara County below 1,000 ft. elevation, which includes most of the mining area. This order specifies standards for vegetation management, sediment removal, and bank protection and repair, and prohibits maintenance activities resulting in direct or indirect discharge of waste to surface waters or drainage courses; disposal of excavated sediment outside of designated disposal areas; and any discharge of decant water from temporary sediment stockpiles to surface waters or drainage courses. Above 1,000 ft. the County's grading ordinance applies.

Specific projects to implement the Basin Plan amendment will be reviewed and approved by the Water Board. At a minimum, future projects must comply with standard permit conditions in the U.S. Army Corps of Engineers' Nationwide Permits nos. 13 (Bank Stabilization) and 27 (Stream and Wetland Restoration Activities). USACE final approval and issuance of a permit is only valid with CWA 401 certification of the proposed activity, which is made by the Water Board. Section 401 requires the Water Board to certify that such projects comply with water quality standards, and as such, Section 401 certifications often include conditions that are more stringent than the federal requirements. Federal permit conditions require, for instance, implementation of routine and standard erosion control best management practices and proper construction site management.

Furthermore, construction projects over one acre in size require a general construction National Pollutant Discharge Elimination System permit and preparation and implementation of a storm water pollution prevention plan. See the explanation for VI (b) above for erosion control permit requirements.

Therefore, the Basin Plan amendment will not result in substantial erosion, and its impacts will be less-than-significant.

d) As stated in the previous response, the Basin Plan amendment may involve localized, minor alteration of stream channels during removal and/or stabilization of mining waste in the mining areas high in the Guadalupe River watershed. In areas downstream of the mines, TMDL project goals include isolating mercury-laden sediment and restoring channels to pre-mining period dimensions and flow capacity. Basin Plan amendment-related activities will not substantially increase impervious surface area, or peak flow releases from dams in any part of the watershed.

Furthermore, permit conditions in the Water Board's Order R2-2002-0028, *Waste Discharge Requirements and Water Quality Certification for Santa Clara Valley Water District, Multi-Year Stream Maintenance Program, Santa Clara County*, specifically designed to prevent flooding, will apply to downstream projects.

Therefore, the Basin Plan amendment will not result in significant impacts related to increased flooding.

e) Basin Plan amendment-related activities are, by design, intended to decrease peak runoff rates from upland land uses, as needed to reduce sediment inputs from hillslopes and channel erosion. Therefore, the Basin Plan amendment will not increase the rate or amount of runoff or exceed the capacity of storm water drainage systems and no adverse impacts will occur.

f) Basin Plan amendment-related activities are intended to reduce erosion and improve water quality. Therefore, the Basin Plan amendment will not degrade water quality and no adverse water quality impacts will occur.

g) The Basin Plan amendment does not include construction of housing. Therefore no housing will be placed within the 100-year flood hazard zone as a result of the proposed action. No flood hazard impacts will occur.

h) The Basin Plan amendment does not include construction of structures that could impede or redirect flood floes within a 100-year flood hazard zone and no adverse flooding impacts will occur.

i) The Basin Plan amendment does not require or foresee construction or modification of dams or levees or activities that will expose people to significant damage from dam or levee failure. Therefore no people or structures will be exposed to risk of loss, injury, or death from flooding or dam or levee failure.

j) Basin Plan amendment-related construction would occur upstream of the tidally influenced stream channel and will not be subject to substantial risks due to inundation by seiche, tsunami, or mudflow.

*IX. Land Use and Planning*

a) Basin Plan amendment-related grading would be located in open space and rural areas. Projects will be limited in scale and will not divide any established community. No adverse land use impact will occur.

b) Because projects proposed to comply with Basin Plan amendment requirements will be subject to local agency review, they will not conflict with any land use plan, policy, or regulation.

c) Because projects proposed to comply with Basin Plan amendment requirements will be subject to local agency review, they will not conflict with habitat conservation plans or natural community conservation plans. Please refer to response to IV. f) Biology. The Basin Plan amendment will not conflict with any habitat conservation plan or natural community conservation plan.

*X. Mineral Resources*

a) Basin Plan amendment-related excavation and construction will occur in an area that was mined for mercury from the mid 1800s to the 1970s. The mines have been closed for nearly 30 years because mercury ore that can be economically extracted has been depleted. Therefore mining waste clean up at the site will not result in the loss of availability of any known mineral resources that could be of value to the region or the residents of the State.

b) Similarly, Basin Plan amendment-related excavation and construction will not be located in areas of mineral resource recovery delineated on any local general plan, specific plan, or other land use plan.

*XI. Noise*

a) Earthmoving and construction could temporarily generate noise. Projects proposed to comply with requirements derived from the Basin Plan amendment will be required to be consistent with the local agencies' own standards.

b) Future projects designed to comply with requirements derived from the Basin Plan amendment, which involve earthmoving or construction, could result in temporary ground-borne vibration or noise. The Santa Clara County Noise Ordinance sets specific limits on exterior noise; varying depending on land use and ranging from 45 decibels for low-density residential areas to 75 decibels for heavy industrial areas. The ordinance limits noise-generating activities to the hours between 7:00 a.m. and 7:00 p.m Monday through Saturdays; no activities that could create a noise disturbance permitted on Sundays or holidays. Basin Plan amendment-related grading activities will be required to comply with all local ordinances to keep noise levels to less-than-significant levels. Therefore, the Basin Plan amendment will not result in excessive groundborne vibration or groundborne noise levels.

c) The Basin Plan amendment will not cause any permanent increase in ambient noise levels. Any noise will be short-term in nature. Therefore ambient noise impacts will be less than significant.

d) To comply with requirements derived from the Basin Plan amendment, specific projects involving earthmoving or construction, which could result in temporary noise impacts, are reasonably foreseeable. Noise-generating operations must comply with local noise ordinances, as described in XI (b), above. Compliance with local ordinances assures us that the Basin Plan amendment will not result in substantial temporary or periodic increases in noise levels in the project vicinity.

e) San Jose International Airport is located in the downstream portion of the Guadalupe River watershed. The airport is protected by flood protection levees that are part of the lower Guadalupe River Flood Control Project. No additional mercury mining waste clean up actions would occur in the vicinity. The Basin Plan amendment will not subject people living or working within two miles of the airport to excessive noise levels.

f) The Guadalupe River watershed does not contain any private airports and no impacts will result from airport-generated excessive noise.

*XII. Population and Housing*

a) The Basin Plan amendment will not result in population growth in the Guadalupe River watershed. No new homes, businesses, roads, or other infrastructure are reasonably foreseeable consequences of compliance with the amendment.

b) The Basin Plan amendment could affect private property in populated areas of the watershed, but it will not displace any housing or necessitate construction of replacement housing elsewhere.

c) The Basin Plan amendment will not displace any residents of the Guadalupe River watershed, or create a need for the construction of replacement housing and no impacts will occur.

*XIII. Public Services*

a) The Basin Plan amendment will not lead to construction or remodeling of government facilities, or have any impacts on service ratios, response times or any other aspect of public services such as fire protection, police protection, schools, or parks, and no adverse impacts to public services will result.

*XIV. Recreation*

a) The Basin Plan amendment could result in temporary closure of portions of Almaden Quicksilver County Park (New Almaden Mining District), Santa Teresa County Park (Bernal mine), open space (Santa Teresa mine), and quarry operations (Hillsdale mine) during mining waste characterization and clean up. These short term closures could result in increased numbers of visitors to other portions of the parks or quarry, or perhaps, to other parks and open space destinations in the vicinity. However, any such park-use displacement will be temporary, and the project will not result in substantial physical deterioration of park, recreation or quarry facilities. Potential changes in recreational use patterns are expected to cause less than significant impacts on the environment. No recreational facilities will need to be constructed or expanded.

b) The Basin Plan amendment could result in mining waste cleanup activities that could result in changes in recreational use patterns. These changes will not result in construction or expansion of recreational facilities that could have an adverse affect on the environment. Any short-term changes will be less than significant.

*XV. Transportation / Traffic*

a) To comply with requirements derived from the Basin Plan amendment some hauling of mining waste from future work sites could occur. Mining waste will be removed from potentially extensive areas of the mined lands, and from limited areas in downstream creek channels. This material may be loaded onto trucks and hauled to an appropriate disposal site. This activity could contribute to short term, local increases in traffic during cleanup operations. Roads in the vicinity of proposed cleanup locations are narrow rural roads and an increase in truck traffic could result in congestion at intersections and impact safety. Compliance with County traffic regulations, established truck haul routes and weight limits will limit these temporary transportation impacts to a less-than-significant level.

b) Because the Basin Plan amendment will not increase population or provide employment, it will not generate any ongoing motor vehicle trips and will not affect level of service standards established by the county congestion management agency. Therefore, the Basin Plan amendment will not result in significant impacts.

c) The Basin Plan amendment will not affect air traffic and no impacts are anticipated.

d) The Basin Plan amendment does not include provisions for the construction of new roads or modifications to existing roads, and no new hazards in the road network in the Guadalupe River watershed will occur.

e) The Basin Plan amendment will result in grading and erosion control actions on unpaved roads that are not typically used for emergency access. Therefore, the project will not result in inadequate emergency access and on impacts will occur.

f) Because the Basin Plan amendment will not increase population or provide employment, it will not affect parking demand or supply, and no impacts will occur.

g) Because the Basin Plan amendment will not generate ongoing motor vehicle trips, it will not conflict with adopted policies, plans, or programs supporting alternative transportation.

*XVI. Utilities and Service Systems*

a) The project amends the Basin Plan, which is the basis for wastewater treatment requirements to improve water quality and the environment in the Bay Area. Therefore the Basin Plan amendment will be consistent with such requirements.

b) The Basin Plan amendment does not include changes to wastewater treatment facilities, therefore no impacts will occur.

c) Construction of any new storm drainage system or expansion of existing facilities as a result of the Basin Plan amendment project is speculative at this time. Local drainage improvements could be included as erosion control measures at historic mine sites but these features are unlikely to be connected to municipal storm drainage systems, and in any case will be subject to future regulatory review and permitting.

d) Because the Basin Plan amendment will not increase population or provide employment, it will not require an ongoing water supply. It will also not require ongoing wastewater treatment services.

e) Because the Basin Plan amendment will not increase population or provide employment, it will not require an ongoing water supply. It will also not require ongoing wastewater treatment services.

f) Basin Plan amendment implementation will not generate solid waste other than the relatively small portion of mining waste that might be off-hauled. Mining waste will be transported to a Class I or II landfill with adequate capacity to receive the waste. Mining waste is not expected to be disposed of at a local Class III landfill facility and the Basin Plan amendment will not generate a long-term waste stream or substantially affect municipal solid waste generation or landfill capacities.

g) Basin Plan amendment implementation will comply with all federal, state, and local statutes and regulations related to soil waste disposal.

*XVII. Mandatory Findings of Significance*

a) As discussed in the explanations for Section IV Biological Resources above, while the Basin Plan amendment is designed to benefit, enhance, restore and protect biological resources, including fish, wildlife, and rare and endangered species, it is possible that specific mining waste cleanup or creek stabilization projects required for compliance and involving earthmoving activities and landscape modifications could affect sensitive or special status species, either directly or through habitat modifications. However, substantial, existing, and adequate protections are afforded by the Water Board's Order R2-2002-0028; by the U.S. Army Corps of Engineers nationwide permits; by requirements in the County of Santa Clara's comprehensive grading ordinance, and by permit requirements and project oversight provided by state and federal environmental protection agencies.

The Basin Plan amendment will not degrade the quality of the environment. It is designed specifically to benefit fish and wildlife species by decreasing the amount of mercury in sediment, water and fish tissue, both in the Guadalupe River watershed and the San Francisco Bay, and to enhance, restore and protect habitat in the watershed.

The Water Board's adaptive management approach to implementation provides additional safeguards and guarantees that future implementation of the Basin Plan amendment will be carried out in ways that enhances, and does not degrade, the quality of the environment in the Guadalupe River watershed.

For all of these reasons, we find that the project does not have the potential to degrade the quality of the environment, substantially reduce habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or reduce the number or restrict the range of a rare or endangered plant or animal.

b) This Basin Plan amendment is specifically designed to restore natural conditions and enhance habitat values in the Guadalupe River watershed. As discussed above, the Basin Plan amendment could pose some less-than significant adverse environmental impacts related to earthmoving and construction operations. These impacts would be individually limited, and most would be of short-term duration. It is not anticipated that the construction and restoration activities associated with the proposed amendment would combine with other planned restoration projects to result in cumulatively considerable impacts. In part, this is due to the phased and adaptive nature of the implementation plan. As specific implementation projects are developed and proposed, they will be subject to approval by the Water Board, which would either disapprove projects with significant and unacceptable impacts or require mitigation measures, such as implementation of best construction management practices, to ensure that impacts remain less than significant.

c) The Basin Plan amendment will not cause any substantial adverse effects to human beings, either directly or indirectly. The amendment's purpose is to restore beneficial uses in the watershed by minimizing mercury in the environment. Human beings should benefit directly from implementation of actions designed to enhance healthy fish populations; aesthetic attributes, and recreational opportunities.

#### 10.4.3 ANALYSIS OF POTENTIAL CUMULATIVE IMPACTS

As indicated in the explanations for our responses to Mandatory Findings of Significance questions above, adoption of the Basin Plan amendment will not result in significant adverse cumulative impacts to the Guadalupe River watershed environment.

This section provides the rationale for our determination of less-than-significant cumulative impacts, per (CEQA Guidelines §15130). As defined in Guidelines §15130(a)(1), "a cumulative impact consists of an impact which is created as a result of the combination of the project…together with other projects causing related impacts." In the case of the Guadalupe River watershed mercury TMDL project, such other closely related projects would be those that could result in increased mining waste in water bodies, or in environmental changes that could affect conversion of mercury to its highly toxic form, methylmercury.

Past, present, and reasonably foreseeable future projects that could have environmental impacts similar to those of the Basin Plan amendment project are identified in Table 10.1, below. These include projects involving earth moving and construction activities in soils with elevated mercury concentrations, such as construction grading associated with mining waste cleanup and disturbance of in-channel sediments; reservoir management plans and habitat conservations plans that could include actions affecting mercury concentrations in soil and water and the attainment of TMDL targets in the Guadalupe River watershed; and adoption of a future region-wide TMDL for mercury in reservoirs. Table 10.1 is limited to projects located in the portion of the Guadalupe River watershed covered by the proposed Basin Plan amendment (i.e., all waters in the Guadalupe River watershed except Los Gatos Creek and its tributaries upstream of Vasona Dam, Lake Elsman, Lexington Reservoir, and Vasona Lake).

All of these projects are specifically designed to eliminate mercury discharges to the waters of the Guadalupe River watershed as they improve habitat values. Many involve short-term construction in or near waters of the watershed, and all must comply with CEQA, which requires mitigation of any environmental effects. For these reasons, and because the Basin Plan amendment project will not in of itself create significant impacts, there will be no cumulative impacts attributable to this project.

## Table 10.1 Projects Considered in the Cumulative Environmental Impact Analysis

| Project | Status* | Project Sponsor |
|---|---|---|
| Mining waste remediation in Almaden Quicksilver County Park:<br>• Mine Hill<br>• Hacienda Furnace Yard<br>• West bank of Alamitos Creek in the vicinity of Hacienda Furnace Yard<br>• Senador mine<br>• Enriquita mine<br>• San Mateo mine | C | Santa Clara County Parks Department, under DTSC order |
| 7,000 linear feet of Guadalupe Creek restored and mining waste removed, as mitigation for the Downtown Guadalupe River Flood Control Project | C | Santa Clara Valley Water District |
| Lower Guadalupe River Flood Control Project (reduce mining waste in the stream channel) | C | Santa Clara Valley Water District |
| Alamitos Creek Restoration under 319(h) Grant | C | Santa Clara Valley Water District |
| Stream Maintenance Program (below 1,000 ft. elevation) | O | Santa Clara Valley Water District |
| Mining waste remediation in Almaden Quicksilver County Park:<br>• 150-foot reach of Alamitos Creek at Hacienda Furnace Yard<br>• 300-foot reach of Deep Gulch Creek<br>• 2 areas in Jacques Gulch | P | Santa Clara County Parks Department, Natural Resources Damages Assessment settlement with U.S. FWS |
| Upper Guadalupe River Flood Control Project (reduce mining waste in the stream channel) | P | Santa Clara Valley Water District |
| Santa Clara Valley Habitat Conservation Plan | F | Santa Clara County and partners |
| Fish Habitat Management Plan (for the Guadalupe River and Coyote and Stevens creeks) | F | Santa Clara Valley Water District |
| San Francisco Bay Region Reservoir Mercury TMDL | F | Water Board |

* C=Completed, O=On-going, P=Proposed and Funded, F=reasonably foreseeable future

In accordance with CEQA, this analysis does not include a discussion of impacts that do not result in part from the proposed Basin Plan amendment. Environmental impacts identified as "no impact" in the environmental checklist are not evaluated in this cumulative analysis because they would make no contribution to potentially cumulative future impacts. However, actions associated with improving water quality through the TMDL project, if occurring contemporaneously with other construction projects, could contribute to temporary cumulative negative impacts to air quality, cultural resources, biological resources, and traffic. Such potential cumulative effects are discussed below.

#### Air Quality

BAAQMD CEQA Guidelines state that if a project is found not to individually cause significant impacts to air quality, cumulative impacts should be determined based on an evaluation of the project's consistency with applicable General Plans and whether or would effect conformance of the General Plan with the regional air quality plan. The proposed Basin Plan amendment is located in Santa Clara County and the City of San Jose. Reasonably foreseeable compliance measures would not affect the conformance of either the City or County General Plan with the most recent regional air quality plan (the *Bay Area '00 Clean Air Plan*) because it would not result in an operational activity that would increase emissions in the area (such as contribute to the increase in population or long-term increase in vehicular traffic). Therefore, the proposed Basin Plan amendment would not result in cumulative impacts to regional air quality.

#### Biological Resources

Reasonably foreseeable compliance measures to reduce mining waste in mine areas and in creeks and rivers downstream of mine areas could affect riparian and wetland resources. Potential local impacts to biological resources would be mitigated by the standard requirements of Clean Water Act Section 401 water quality certifications, which require mitigation of temporary impacts to sensitive wetlands, as well as monitoring and reporting that ensure site vegetation and habitat restoration. Compliance with permit conditions of the Water Board, the California Department of Fish and Game, and U.S. Fish and Wildlife Service would prevent cumulative biological impacts from occurring.

#### Cultural Resources

As indicated in the environmental analysis, above, Santa Clara County adheres to rigorous historic preservation protocols for areas in Almaden Quicksilver County Park (in the New Almaden Mining District) (a registered National Historic Landmark). Santa Clara County has also adopted policies for archeological resource identification, protection, and mitigation procedures that will ensure protection of these resources on public lands in the watershed. The Santa Clara Valley Water District conducts stream maintenance activities, including minor creek restoration projects, under their Master Maintenance Plan and with mitigation measures specified in the Environmental Impact Report for the Stream Maintenance Plan. These laws, regulations and standard field procedures will prevent cumulative impacts on cultural resources in and near creeks and rivers downstream of the mine areas.

Hydrology and Water Quality

Implementation of the Guadalupe River watershed mercury TMDL project is expected to result in long-term improvement in water quality by reducing mercury mining waste in water bodies and reducing methylmercury concentrations in reservoirs and lakes. The Water Board will in the future develop region-wide mercury TMDL for reservoirs, in order to further reduce mercury concentrations in reservoirs throughout the Bay Area. The reservoirs TMDL will focus on reducing mercury impairment from the atmospheric deposition source. The cumulative effect of other TMDL programs and implementation efforts will be to reduce mercury concentrations in the long term to background levels appropriate to the Coast Range geology. These projects will be designed to meet Clean Water Act requirements. They should result in long-term improvements in water quality.

### 10.4.4 Analysis of Alternatives to the Project

Our analysis includes the following alternatives:

1. No action/no Basin Plan amendment
2. Extend implementation over a longer period
3. Adopt U.S. EPA's methylmercury criterion
4. Adopt allocations different from those proposed in this Staff Report

In defining and presenting reasonable alternatives to the proposed Basin Plan amendment, we discuss how each alternative could affect foreseeable environmental outcomes, and the extent to which each alternative would achieve the project objectives.

A discussion of the preferred alternative, the Proposed Basin Plan amendment, is provided at the end of the alternatives discussion.

In addition, we briefly discuss three alternative regulatory approaches, which we considered and rejected.

In order to be considered under the requirements of the California Environmental Quality Act (CEQA), alternatives must "feasibly attain most of the basic objectives of the project but…avoid or substantially lessen any of the significant effects of the project" (CEQA Guidelines §15126.6(a)). Similarly, in §15126.6(b) the Guidelines interpret Public Resources Code §21002.1 as follows: "the discussion of alternatives shall focus on alternatives to the project…which are capable of avoiding or substantially lessening any significant effects of the project, even if these alternatives would impede to some degree the attainment of the project objectives, or would be more costly."

As stated in Section 2.2 of this Staff Report, the objectives of the Basin Plan amendment are as follows:

*The proposed Basin Plan Amendment is intended to reduce existing and future mercury discharges to, and methylmercury production in, waters of the Guadalupe River watershed and San Francisco Bay. Specific objectives of the project are as follows:*

- *Revise mercury water quality objectives to reflect current scientific information and the latest U.S. EPA and U.S. Fish and Wildlife Service guidance*

- *Restore and protect beneficial uses in waters of the Guadalupe River watershed by attaining TMDL numeric targets and water quality standards while maintaining—enhancing where possible—habitat for wildlife*
- *Restore and protect downstream beneficial uses by reducing mercury discharges to San Francisco Bay from legacy and urban stormwater runoff sources*
- *Favor implementation actions with multiple benefits; phase implementation to control upstream sources before downstream sources are addressed and while methylmercury controls are being developed*
- *Implement effective source control measures for mining waste at mine sites and in downstream depositional areas*
- *Complete studies of methylmercury and bioaccumulation controls in reservoirs and lakes, and implement effective controls*
- *Achieve the legacy mercury and urban stormwater runoff mercury load allocations assigned to the Guadalupe River watershed by the San Francisco Bay mercury TMDL*
- *Avoid imposing regulatory requirements that are more stringent than necessary to meet numeric targets and attain water quality standards; Avoid actions that will have unreasonable costs relative to their environmental benefits*
- *Comply with the Clean Water Act requirements to adopt TMDLs for 303(d) listed water bodies and comply with the State Water Board's directive to integrate the Bay and Guadalupe mercury TMDLs*
- *Consider site-specific factors relating to mercury sources and methylmercury production, ambient conditions, watershed characteristics, and response to management actions; Avoid arbitrary decisions and speculation when computing loads, setting targets, setting allocations, determining implementation actions, and defining a margin of safety*
- *Establish allocations based on the goals of (a) eliminating inputs of mercury caused by anthropogenic activities, particularly mining and urban stormwater runoff, and (b) minimizing the transformation of mercury to methylmercury caused by anthropogenic activities, particularly the construction and operation of reservoirs, lakes and shallow impoundments*
- *Provide details of an implementation plan that includes: a description of the nature of actions necessary to meet allocations and targets and thereby achieve water quality standards; a schedule for actions to be taken; and a description of monitoring to be undertaken to determine progress toward meeting allocations, targets and water quality objectives*
- *Attain the TMDL targets in as short a time as feasible, and no longer than 20 years*

- *Base decisions on readily available information on ambient conditions, loads, fish consumption patterns, and fate and effects; Establish a decision-making framework where management actions adapt to future knowledge or conditions*
- *Correct an error made during the 2005 Basin Planning process, in which the reference to the Guadalupe River was inadvertently removed and replaced with a reference to the Guadalupe Reservoir in Table 2-1, Existing and Potential Beneficial Uses of Water Bodies in the San Francisco Bay Region. Include the Guadalupe River's beneficial uses, as shown in the 1986 Basin Plan: Cold Freshwater Habitat (COLD), Fish Migration (MIGR) (potential), Fish Spawning (SPWN) (potential), Warm Freshwater Habitat (WARM), Wildlife Habitat (WILD), Water Contact Recreation (REC1) (potential); and Noncontact Water Recreation (REC2).*

#### Alternative 1: No action/no Basin Plan Amendment (No Project Alternative)

Under this alternative, which CEQA requires us to evaluate, the Water Board would not amend the Basin Plan to adopt new water quality objectives or the proposed mercury TMDLs, targets, or allocations. Nonetheless, some new implementation activities might be initiated under existing Water Board authority. For example, the Water Board could issue cleanup and abatement orders for mine sites in the absence of a TMDL project. However, if no or few actions were taken to address mercury impairment in Los Alamitos Creek or in reservoirs, mercury concentrations would likely either stay the same or decrease over a much longer timeframe (perhaps many hundreds of years; see Section 7.7, Water Quality Standards Attainment), due to continued discharge of mercury presently stored in the watershed and continued methylation in reservoirs, lakes, and shallow impoundments.

Should the Water Board decline to adopt the mercury TMDLs, the Clean Water Act requires the U.S. Environmental Protection Agency (U.S. EPA) to undertake a TMDL project for the Guadalupe River watershed due to the CWA 303(d) listing of the Guadalupe River as impaired by mercury.. How a U.S. EPA TMDL project would differ from the TMDL project described in the Basin Plan amendment is unknown. The federal agency would identify targets and allocate mercury loads, which the Water Board would be required to incorporate into the Basin Plan along with appropriate implementation.

Under the no-project alternative, TMDL implementation would likely be delayed for an unknown period of time. Negative impacts associated with this alternative are greater than with the proposed project because implementation actions would be delayed while mercury discharges and methylation continue. For this reason, and because U.S. EPA's TMDL development process does not include the California Environmental Quality Act's mandates for public participation, we reject this alternative.

#### Alternative 2: Extend Implementation Over a Longer Period

Under this alternative, mercury allocations to sources would be phased in over a longer period of time than the twenty years proposed in the Basin Plan amendment. Most of the project objectives would be met, although attainment of the designated beneficial uses would be postponed, and wildlife and public health would remain in jeopardy for a longer period.

As studies and early implementation actions progress and we engage in our adaptive implementation process, it may become necessary to extend the implementation timeframe for the Guadalupe River watershed mercury TMDL project. At this time, however, we believe the ten year period of Phase I is a reasonable timeframe for mine site remediation and studies of the extent of calcine deposits in creeks to be completed, and for methylmercury control technology in reservoirs to be tested and evaluated. Because we recognize no current reasons to extend the implementation timeframe, and because doing so would not meet the project objective to "complete implementation of the TMDL in as short a time as is feasible and no longer than 20 years," we reject this alternative.

#### Alternative 3: Adopt U.S. EPA's Methylmercury Criterion

Under this alternative, the Water Board would adopt a single fish tissue target, equal to the U.S. EPA fish tissue criterion of 0.3 mg methylmercury per kg fish tissue. This alternative would meet most of the objectives of the Basin Plan amendment.

U.S. EPA intends its criterion to protect humans who consume fish. We believe this criterion may not protect wildlife, such as osprey, because pound-for-pound, piscivorous wildlife eats more fish than humans (see Section 5). It is therefore less protective of the beneficial uses of the Guadalupe River watershed than the water quality objectives and TMDL targets in the Basin Plan amendment.

The California Toxics Rule (CTR) water column value for mercury, 0.050 µg/l (30-day average), shares EPA's intent to protect humans who eat fish. The State Water Resources Control Board is in the process of developing a statewide mercury standard that would update the CTR value, consistent with the method used to develop EPA's criterion and likely based on California-specific fish consumption rates. The Basin Plan amendment recognizes this effort; the Water Board may consider adopting the new statewide standard when it is established. Undertaking a separate standards action at this time to address human health would be an inefficient use of Regional Water Board staff resources.

Because impacts associated with this alternative are greater than the proposed project, we reject this alternative.

#### Alternative 4: Adopt Allocations different from those proposed in this Staff Report

Under this alternative, the Water Board would adopt allocations other than those recommended and listed in Table 8.1. We considered alternative allocations for mining waste (see Section 8.1) and in reservoirs and lakes (see Section 8.2). In Table 10.2 we summarize the alternative allocations we considered but rejected.

**Table 10.2 Alternative Allocations**

| Source Category | Rejected Allocations | Basis of Recommended Allocations |
|---|---|---|
| Mining Waste | Mass loads<br>Pre-mining surface soil mercury concentrations<br>Mineralized zone perimeter sediment mercury concentrations | Reference Reservoir<br>San Francisco Bay mercury TMDL |
| Methylmercury in reservoirs and lakes | Total or dissolved total mercury<br>Methylmercury allocations based on:<br>National default data<br>Annual average concentrations<br>Depth-averaged data<br>Dissolved methylmercury | Methylmercury toxicity<br>Methylmercury allocations based on:<br>Site-specific data<br>Seasonal peak concentrations<br>Depth-specific (hypolimnion) data<br>Total methylmercury |

We rejected these allocations for the reasons provided in Sections 8.1 and 8.2, including lack of data to support the alternatives, more costly monitoring that would divert funding away from implementation actions, more precise focus on methylmercury that accumulates seasonally in the hypolimnion, and to protect consumers of benthic organisms as well as consumers of fish.

#### *PREFERRED ALTERNATIVE: THE PROPOSED BASIN PLAN AMENDMENT*

Because the proposed Basin Plan amendment will not pose any significant adverse environmental impacts, the alternatives would not avoid or lessen any significant impacts. None of the three alternatives achieves all of the goals of the TMDL project, which include establishing environmental conditions that will result in attainment of beneficial uses in the Guadalupe River watershed, within 20 years. The three alternatives are neither considered to be environmentally superior nor will they have fewer negative impacts than the Basin Plan amendment. The proposed Basin Plan amendment is the preferred project.

#### *ALTERNATIVE REGULATORY APPROACHES, CONSIDERED AND REJECTED*

##### Undertake a Use Attainability Analysis Instead of a TMDL

Beneficial uses of the Guadalupe River watershed that are impaired by mercury are human consumption of fish, and wildlife consumption of fish. (See Section 2.4 of this Staff Report.)

As allowed by 40 CFR 131.10(g)(1-6). the Water Board may undertake a "use attainability analysis," (i.e., remove a beneficial use from the Basin Plan), rather than a TMDL, in certain types of situations, including:

(1) Naturally occurring pollutant concentrations prevent the attainment of the use (g)(1)

(2) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place (g)(3)

(3) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use (g)(4)

The third condition may apply to mercury in the Guadalupe River watershed, if methylmercury production in reservoirs, and bioaccumulation in the watershed's wildlife, cannot be adequately controlled. However, it is not presently possible to determine whether this is the case. In the course of the Water Board's adaptive implementation process, the Board or regulated entities may decide to review beneficial uses in the future, after erosion of mercury mining waste is controlled and methylmercury experiments (see Section 9) are completed. However, a UAA cannot be justified at this time.

#### Set Site Specific Objectives for Mercury in the Guadalupe River watershed

An action to set a site-specific objective modifies a regional water quality objective to address local conditions. Such an objective must be set at a level that will protect all beneficial uses in the watershed or waterbody. Site-specific objectives for mercury are not appropriate for the Guadalupe River watershed because the proposed fish tissue objectives are based on a methylmercury reference dose—not on local conditions.

#### Cover the Guadalupe River Watershed in a Single Permitting Action

Similarly, a single permitting action would not resolve the mercury problem in the Guadalupe River watershed. Permits and orders appropriate to mine site cleanup would differ substantially from permits and orders that would be issued to reduce methylmercury production in lakes and reservoirs, and those required to guide to clean up creek beds, banks, and floodplains.

## 10.5 Economic Considerations

Set forth in this section are economic considerations required in the above-referenced laws. While economics are an important consideration, it is worth noting that when adopting the Porter-Cologne Act, the Legislature declared that all values of the water should be considered, but then went on to provide only broad, non-specific direction for considering economics in the regulation of water quality.

> The Legislature further finds and declares that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved,

beneficial and detrimental, economic and social, tangible and intangible (CWC §13000).

The Porter-Cologne Act directs regulatory agencies to pursue the highest water quality that is reasonable, and one of the factors used to determine what is reasonable is economics. It is clear, though, that economic factors cannot be used to justify a result that would be inconsistent with the federal Clean Water Act or the Porter-Cologne Act. The Water Board is obligated to restore and protect water quality and beneficial uses.

These proposed water quality objectives and TMDLs require implementation and monitoring (compliance) actions for mercury mining waste at mine sites and in depositional areas, and methylmercury production in reservoirs and lakes. The reasonably foreseeable methods of compliance with the proposed Basin Plan amendment vary by mercury source. For mercury mining waste present at mine sites and accumulated in downstream depositional areas, the reasonably foreseeable methods of compliance consist primarily of erosion control, effectiveness monitoring, and coordinated watershed monitoring. For Guadalupe, Almaden, and Calero reservoirs, and Lake Almaden, the reasonably foreseeable methods of compliance consist of developing, testing, and deploying methylmercury controls, such as solar-powered circulators, and coordinated watershed monitoring. For urban stormwater runoff, the reasonably foreseeable methods of compliance consist of coordinated watershed monitoring.

The proposed water quality objectives and TMDLs implementation costs are estimated for these source categories for each of the proposed implementation actions contained in the Basin Plan amendment. We provide an upper and lower range of cost estimates since there is uncertainty about the exact costs given our lack of knowledge on the extent of mercury mining waste in the watershed and developmental state of water column methylmercury controls. In many cases, the particular elements of the implementation action are required to be developed at a future time, and therefore, the specifics are unknown. Cost estimates are projected for the 20-years of phased implementation planned for in this TMDL project. Costs of implementing existing requirements are not included.

#### *IMPLEMENTATION ACTIONS FOR MERCURY MINES*

The proposed Basin Plan amendment requires that responsible parties (see Section 9.3) control erosion of mercury mining waste from the New Almaden Mining District, and the Santa Teresa, Bernal, and Hillsdale Mercury Mines, and conduct monitoring. Implementation actions to prevent further erosion of mercury mining waste by stabilizing and vegetating slopes are described in Section 10.3 (Reasonably Foreseeable Means of Compliance), and in Section 9, Tables 9.1–9.3. Monitoring for erosion control effectiveness, mercury in fish tissue, mercury loads to San Francisco Bay, and special study 3b are described in Sections 9.9 and 9.10.

#### One-time Costs

Staff made several simplifying assumptions in developing the estimated costs to cleanup mine sites. These include:

- Modeling the scope (i.e., site assessment, risk assessment, remedial design, and construction) of future mining waste control efforts on the cleanup actions

completed by Santa Clara County Parks and Recreation Department (County Parks) at the New Almaden Quicksilver County Park (see Section 3.5);
County Parks cleaned up the following five areas: Mine Hill, Hacienda Furnace Yard, Senador Mine, Enriquita Mine, and San Mateo Mine. The projects generally consisted of excavation, hauling, and on-site placement of mining waste; slope re-contouring; stormwater runoff diversion ditches; and re-vegetation

- Reviewing geologic maps of the New Almaden Mining District (Plates 1, 3, and 14, Bailey & Everhart 1964) for the locations and acres of mining waste and dump sites;
  These maps provide the extent of mining waste and dump sites (circa 1947) for the 'New Almaden Mine' (including the 'Mine Hill" site which was cleaned up) and 'Guadalupe Mine'; these maps do not include the other sites in Almaden Quicksilver County Park which have been cleaned up (Hacienda Furnace Yard, and Senador, Enriquita, and San Mateo mines), nor do they provide detailed information on the area between 'New Almaden Mine' and 'Guadalupe Mine', which are separated by 2.3 miles and include Senador, San Mateo, San Antonio, Enriquita, and Providencia mines. These maps also do not indicate how far downstream the waste has eroded. Based on Plate 3, the Mine Hill site was about 2.5 acres

- Calculating a per-unit (i.e., per-acre) cost of cleanup by dividing the size of the New Almaden Quicksilver County Park remediation footprint by the total cost of remediation. We estimate that Mine Hill was one-third of the $6 million total cost of remediation (County Parks 2008.). Therefore, the per-acre estimated cost is $800,000

- Calculating the surface area for each mining waste and dump site;
  The acres of mining waste and dump sites on Plates 3 and 14 (Bailey & Everhart 1964) total approximately 70 acres

- Multiplying the total acreage by the per unit cost for cleanup;
  The estimated total cost is $56,000,000

- Adjusting the cleanup costs for inflation;
  inflation from 1999 (cleanup completed) to 2008 is estimated to be 20.8 percent (NASA 2008). The estimated total cost, adjusted for inflation is $68,000,000 ($68 M)

This cost estimate includes project management, administration, design, and permitting. However, actual costs will depend on site topography, land use intensity, location of mining waste relative to receiving waters, land access, project complexity, and the responsible parties' preferred remedial alternative. The largest factor contributing to uncertainty in this cost estimate is the lack of a site assessment for erosion potential of mercury mining waste both at New Almaden Mining District, and also at the other mines (Santa Teresa, Bernal, and Hillsdale). Over the last 50 years (since the Bailey & Everhart maps were produced), these mining waste dumps likely have eroded and expanded greatly in size.

This hypothesis is supported by continuing high mercury concentrations in stormwater samples collected by County Parks (100,000 ng/l, see 'New Almaden Compared to California's Other Mines' in Section 3.4). See also Figure 3.10, Map of Mercury Concentrations Remaining After Park Cleanup. This map supports a key point from Section 3 that, although progress has been made to cleanup mercury from New Almaden, vastly more remains to be cleaned up in and downstream of the New Almaden Mining District.

Conversely, although unlikely, these mining waste dumps may have eroded to a stable angle of repose, revegetated naturally, and no longer discharge mercury-laden sediment to stormwater. To develop the low and high one-time cost estimates in Table 10.3, we estimate that costs may be as low as one-third of our estimate, or range up to 10 times our estimate (adjusted for inflation), that is, ranging from $23 M to $680 M.

#### Annual Costs

This cost estimate does not include storm water permit, effectiveness monitoring, or reporting costs because these costs are already required for mine sites separately from the TMDL project. Mine sites are required to file notices to comply with California's Industrial Storm Water General Permit (see Section 9.2), implement best management practices (BMPs), conduct effectiveness monitoring, and report on implementation and effectiveness of BMPs. In any case, we estimate these costs would not exceed $15,000 per year, and are insignificant compared to other costs.

This cost estimate does include the monitoring required only by the TMDL project: fish tissue mercury monitoring to assess attainment of targets, mercury loads to San Francisco Bay, and special studies. This monitoring is required for several source categories, and the associated costs are estimated below (see 'Monitoring and Special Studies').

Annual costs include operations and maintenance of erosion control measures at the mercury mine sites, such as maintenance activities required for vegetative cover, and for engineered storm water run-on and run-off facilities (e.g. pipes and v-ditches). We assume these costs consist of:

- Project manager, site inspector, equipment operator, and 2 laborers
- One month per year
- Supplies and equipment rental

We estimate these costs to range from $10,000 to $50,000 per year. A summary of the cost estimate is provided in Table 10.3.

### *IMPLEMENTATION ACTIONS FOR DEPOSITIONAL AREAS*

There are no costs associated with the TMDL project for this source category, namely depositional areas (creek beds, banks, and floodplains, shallow impoundments, and percolation ponds) in creeks and the Guadalupe River downstream of mercury mines. The proposed Basin Plan amendment does not require responsible parties (see Section 9.5) to undertake any new or additional actions. We anticipate that erosion control of mercury mining waste and resuspension of mercury-laden sediment will be undertaken for stream stewardship and flood control purposes. Upon receipt of Clean Water Act Section 401 applications for these projects, the Water Board will impose permit restrictions and effectiveness monitoring. Such Water Board permit conditions are standard operating procedure, and the TMDL project has not appreciably increased the associated costs.

Nonetheless, we provide this cost estimate to assist with fundraising to cleanup arguably the most mercury-polluted waterway in North America: Alamitos Creek between the Hacienda Furnace Yard and Lake Almaden. We strongly encourage creekside property owners and the Santa Clara Valley Water District to undertake a coordinated watershed stewardship project along these 6 miles.

A foreseeable design option for this project will likely include excavation and off-site disposal of mercury-laden sediments, as this is the most permanent means to reduce mercury loads and methylmercury production. A mercury removal and creek restoration project was undertaken in Guadalupe Creek at a cost of $4.5 M per mile. Alamitos Creek is much more contaminated than Guadalupe Creek; in Alamitos Creek, roasted mercury ores (calcines) form the floodplain, banks, and bed for many miles. Therefore, we estimate that Alamitos Creek would cost from 5 to 10 times as much as the project in Guadalupe Creek, for a total cost of $135 M to $270 M. A summary of the cost estimate is provided in Table 10.3.

#### *IMPLEMENTATION ACTIONS FOR RESERVOIRS AND LAKES*

The proposed Basin Plan amendment requires that the responsible party, the Santa Clara Valley Water District, conduct technical studies of hypolimnion methylmercury controls and other reservoir management techniques that have the potential to reduce bioaccumulation of mercury, and implement all reasonable and feasible control actions (see Sections 9.4, 9.8, and 9.9). Costs associated with these technical studies and implementation actions are included herein. This cost estimate does include the monitoring required only by the TMDL project: fish tissue mercury monitoring to assess attainment of targets, mercury loads to San Francisco Bay, and special studies (see 'Monitoring and Special Studies').

#### One-time Costs

The District has already begun technical studies of hypolimnion methylmercury controls and other reservoir management techniques that have the potential to reduce bioaccumulation of mercury. They have estimated these costs at $440,000 for their Phase 1 (baseline sampling, design and deployment of solar-powered circulators in Lake Almaden, and design for Almaden and Guadalupe Reservoirs) (SCVWD 2005). This is the first phase of a three-phase project to evaluate the feasibility of this technology, pilot test a recommended system, and design and install systems in three District reservoirs (Almaden, Calero, and Guadalupe). We estimate that each of Phases 2 and 3, scheduled to run through 2012, will also cost $440,000. Future costs may include the purchase of three solar-powered circulators for Calero Reservoir, estimated at $50,000 each. These one-time costs total approximately $1.5 M.

These technical study results may indicate that solar-powered circulators are not effective, and that alternate technologies are required. Direct delivery of liquid oxygen or ozone is an alternate technology for preventing anoxia in the hypolimnion. These are very high-cost taste and odor control, and fishery preservation, methods deployed in a few reservoirs in California, (e.g. EBMUD's Camache Reservoir). We estimate that the cost of liquid oxygen or ozone is 10 times the cost of solar-powered technologies. Given the uncertainty in technology to be deployed, we estimate the one-time costs may range from $1.5 M to $15 M.

#### Annual Costs

The solar-powered circulators will require replacement. They are anticipated to have an approximately 15-year service life. We estimate replacement costs for 12 solar-powered circulators once in this 20-year period, adjusted for inflation (35.2 percent from 2005 to 2020), yields an annualized cost of $40,000. If, however, either liquid oxygen or ozone is used, then the annual costs will be considerably higher due to the cost of electricity. We assume they will rely on the existing, conventional power sources for this electricity, and the cost will be 10 times the annual costs for solar-powered circulators. The annual costs for methylmercury range from $40,000 to $400,000. A summary of the cost estimate is provided in Table 10.3.

### *Implementation Actions for Urban Stormwater Runoff*

There are no costs for implementation actions associated with the TMDL project for this source category (they were previously estimated in the San Francisco Bay mercury TMDL staff report, SFBRWQCB 2006). However, there are costs associated with fish tissue mercury monitoring to assess attainment of targets, mercury loads to San Francisco Bay, and special studies (see 'Monitoring and Special Studies').

### *Monitoring and Special Studies*

This section presents a cost estimate for fish tissue mercury monitoring to assess attainment of targets, monitoring mercury loads to San Francisco Bay, and special studies. We have calculated these costs on an annual basis.

Fish mercury monitoring is scheduled to occur at least 15 times over 20 years. We estimate the cost of each event, in 2005 dollars, is $100,000. The total cost, adjusted for inflation (35.2 percent from 2005 to 2020), yields an annualized cost of $101,400, which rounds to $100,000.

Monitoring of mercury load to San Francisco Bay is required at two sites (Gage 23b and Highway 101) for the first five years, and at one site for the remaining 15 years (Highway 101). Automated turbidity monitoring is required continuously at both sites. During each of four five-year monitoring cycles, less intensive sampling (only peak storms) is required in 4 of 5 years, and more intensive sampling (both small and peak storms) in one year. District staff has estimated this sampling effort costs approximately $1 M for each 5-year effort at each site, which yields a total cost of $5 M. This total cost adjusted for inflation (35.2 percent from 2005 to 2020; $6.8), yields an annualized cost (rounded) of $300,000

Special studies have not yet been scoped in detail. For this economic considerations analysis, we assume these costs are $200,000 per year for 10 years, which yields $100,000 per year over the 20-year period of this TMDL project.

A summary of the cost estimate is provided in Table 10.3.

##### *GRAND TOTAL COST ESTIMATE*

The grand total estimated costs to implement these TMDLs range from $160 M to $1 billion (B). A summary of the combined total cost estimate is provided in Table 10.3.

**Table 10.3 Summary of Estimated Costs for Guadalupe River Watershed Mercury TMDL Project Implementation (Years 0 through 20)**

| Implementation Actions | One-Time Costs | | Annual Costs | | 20-year Costs | |
|---|---|---|---|---|---|---|
| | Low | High | Low | High | Low | High |
| **Mercury Mining Waste at Mine Sites** | $23 M | $680 M | $10,000 | $50,000 | $23 M | $700 M |
| **Mercury Mining Waste in Alamitos Creek** | $135 M | $270 M | $135 M | $270 M | $135 M | $270 M |
| **Reservoirs and Lakes** | $1.5 M | $15 M | $40,000 | $400,000 | $2.3 M | $23 M |
| **Monitoring and Special Studies** | - - | - - | - - | - - | $600,000 | $10 M |
| **GRAND TOTAL** | - - | - - | - - | - - | **$160 M** | **$ 1 B** |

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# APPENDIX A – DATA

**Table A.1 Data for Figure 2.2, Guadalupe Reservoir Fish 1971–2004**

| Date | Species | Mercury (ppm) | Length (cm) |
|---|---|---|---|
| Jul-71 | Rainbow Trout | 0.81 | 34 |
| Jul-71 | Rainbow Trout | 0.84 | 34 |
| Jul-71 | Rainbow Trout | 1.1 | 23 |
| Jul-71 | Rainbow Trout | 1.4 | 20 |
| Jul-71 | Rainbow Trout | 1.5 | 19 |
| Jul-71 | Rainbow Trout | 2.3 | 20 |
| 10/23/86 | Blue Gill | 0.8 | 16 |
| 10/23/86 | Blue Gill | 1.1 | 19 |
| 10/23/86 | Blue Gill | 1.3 | 17 |
| 10/23/86 | Blue Gill | 1.4 | 19 |
| 10/23/86 | Blue Gill | 1.4 | 17 |
| 10/23/86 | Blue Gill | 1.5 | 18 |
| 10/23/86 | Blue Gill | 1.9 | 17 |
| 10/23/86 | Blue Gill | 1.9 | 17 |
| 10/23/86 | Blue Gill | 2.0 | 18 |
| 10/23/86 | Blue Gill | 2.0 | 19 |
| 10/23/86 | Blue Gill | 2.2 | 19 |
| 10/23/86 | Blue Gill | 2.3 | 23 |
| 10/23/86 | Blue Gill | 2.3 | 18 |
| 10/23/86 | Blue Gill | 2.3 | 18 |
| 10/23/86 | Blue Gill | 2.3 | 17 |
| 10/23/86 | Blue Gill | 2.4 | 18 |
| 10/23/86 | Blue Gill | 2.9 | 20 |
| 10/23/86 | Blue Gill | 3.3 | 21 |
| 10/23/86 | Blue Gill | 3.8 | 21 |
| 05/28/03 | Black Crappie | 1.7 | 15.2 |
| 05/28/03 | Black Crappie | 1.7 | 15.1 |
| 05/28/03 | Black Crappie | 1.7 | 15.9 |
| 05/28/03 | Black Crappie | 1.8 | 15.5 |
| 05/28/03 | Black Crappie | 1.9 | 16.0 |
| 05/28/03 | Black Crappie | 1.9 | 14.8 |
| 05/28/03 | Black Crappie | 2.0 | 15.1 |
| 05/28/03 | Black Crappie | 2.0 | 13.0 |
| 05/28/03 | Black Crappie | 2.1 | 17.2 |
| 05/28/03 | Black Crappie | 2.1 | 17.1 |
| 05/28/03 | Black Crappie | 2.9 | 27.5 |
| 05/28/03 | Largemouth bass | 2.6 | 27.3 |
| 05/28/03 | Largemouth bass | 3.1 | 29.6 |
| 05/28/03 | Largemouth bass | 3.1 | 39.6 |
| 05/28/03 | Largemouth bass | 3.2 | 31.6 |
| 05/28/03 | Largemouth bass | 3.6 | 42.8 |
| 05/28/03 | Largemouth bass | 3.7 | 37.3 |
| 05/28/03 | Largemouth bass | 3.8 | 35.9 |

**Table A.1 Data for Figure 2.2, Guadalupe Reservoir Fish 1971–2004**

| Date | Species | Mercury (ppm) | Length (cm) |
|---|---|---|---|
| 05/28/03 | Largemouth bass | 3.9 | 35.6 |
| | | | |
| 05/28/03 | Largemouth bass | 4.0 | 38.4 |
| 05/28/03 | Largemouth bass | 4.0 | 39.8 |
| 05/28/03 | Largemouth bass | 4.5 | 36.5 |
| 05/28/03 | Largemouth bass | 4.6 | 36.7 |
| 05/28/03 | Largemouth bass | 4.7 | 37.0 |
| 05/28/03 | Largemouth bass | 5.5 | 42.9 |
| 05/28/03 | Largemouth bass | 5.8 | 50.5 |

Citations:
1971 data from (Woodward-Clyde 1992)
1986 data from (TSMP 1978-2000)
2003 data from (DFG 2003)
2004 data summary is provided on Table A.8a & A.8b, below

**Table A.2a Summary of Reservoir Bottom Sediment Mercury**

Citation: Table 1 Guadalupe River Watershed Reservoir Sediment Sampling (Tetra Tech 2005b)

| | Lexington Reservoir | Calero Reservoir | Guadalupe Reservoir | |
|---|---|---|---|---|
| | Total mercury (mg/kg, dry basis) | | | |
| Mean | 0.11 | 0.42 | 3.32 | |
| Median | 0.10 | 0.39 | 2.82 | (2.95)* |
| Minimum | 0.07 | 0.10 | 0.42 | |
| Maximum | 0.18 | 0.84 | 7.29 | (337.9)* |
| n | 20 | 18 | 16 | |

*One sample from Guadalupe Reservoir was not included in the statistical analyses;
the values shown in parentheses include all samples from Guadalupe Reservoir.

## Table A.2b Reservoir Bottom Sediment Mercury and Percent Fines

*Citation: Appendix Table 1* Guadalupe River Watershed Reservoir Sediment Sampling *(Tetra Tech 2005b)*

| Sample ID | Total Hg mg/kg (dry basis) | Percent Fines* | Sample ID | Total Hg mg/kg (dry basis) | Percent Fines* | Sample ID | Total Hg mg/kg (dry basis) | Percent Fines* |
|---|---|---|---|---|---|---|---|---|
| Lexington Reservoir | | | Calero Reservoir | | | Guadalupe Reservoir | | |
| LR-1-A | 0.12 | 98.4 | CR-1-A | 0.13 | 44.3 | GR-1-A | 3.32 | 100 |
| LR-1-B | 0.11 | 100 | CR-1-B | 0.47 | 100 | GR-1-B-1 | 3.91 | 100 |
| LR-1-C | 0.07 | 100 | CR-1-C | 0.36 | 100 | GR-1-B-2 | 3.56 | 100 |
| LR-2-A | 0.15 | 85.2 | CR-2-A | 0.68 | 100 | GR-1-C | 4.19 | 96.5 |
| LR-2-B | 0.16 | 95.8 | CR-2-B | 0.52 | 100 | GR-2-A | 1.65 | 100 |
| LR-2-C | 0.13 | 100 | CR-2-C | 0.49 | 100 | GR-2-B | 1.95 | 100 |
| LR-3-A | 0.11 | 100 | CR-3-A | 0.37 | 100 | GR-2-C | 2.68 | 100 |
| LR-3-B | 0.1 | 100 | CR-3-B | 0.37 | 100 | GR-3-A | 2.31 | 100 |
| LR-3-C | 0.1 | 100 | CR-3-C | 0.4 | 100 | GR-3-B | 2.31 | 100 |
| LR-4-A-1 | 0.1 | 100 | CR-4-A | 0.38 | 98.8 | GR-3-C | 2.95 | 100 |
| LR-4-A-2 | 0.07 | 100 | CR-4-B-1 | 0.42 | 100 | GR-4-A | 6.67 | 20.1 |
| LR-4-B | 0.08 | 100 | CR-4-B-2 | 0.31 | 95.9 | GR-4-B | 1.94 | 72.7 |
| LR-4-C | 0.09 | 100 | CR-4-C | 0.29 | 95.3 | GR-4-C | 5.69 | 96 |
| LR-5-A | 0.08 | 100 | CR-5-A | 0.25 | 81.9 | GR-5-B | 2.27 | 23.7 |
| LR-5-B | 0.07 | 99.5 | CR-5-B | 0.55 | 14.7 | GR-5-C | 7.29 | 72.9 |
| LR-5-C | 0.08 | 98 | CR-5-C | 0.1 | 56 | GR-6-A | 337.9 | 29.3 |
| LR-6-A | 0.09 | 97.3 | CR-7-A | 0.61 | 73.3 | GR-7-A | 0.42 | 75.8 |
| LR-6-B | 0.09 | 97.9 | CR-7-B | 0.84 | 54.4 | | | |
| LR-7-A | 0.18 | 100 | | | | | | |
| LR-7-B | 0.17 | 100 | | | | | | |
| | | | | | | | | |
| min | | 85 | | | 15 | | | 20 |
| mean | | 99 | | | 84 | | | 82 |
| median | | 100 | | | 99 | | | 100 |
| max | | 100 | | | 100 | | | 100 |

**Table A.3a Lexington Reservoir Effluent Field Measurements (2004)**

*Citation: Data collected by Light, Air, & Space Co. for SCVWD*

| Date | Time | Depth (ft) | Temp (° C) | pH | Conductivity (mhos/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L) | Salinity (%) |
|---|---|---|---|---|---|---|---|---|
| 1/12/2004 | 13:10 | NR | 10.7 | 8.15 | 0.367 | 121 | 13.98 | 0.01 |
| 3/4/2004 | 15:37 | 1 | 12.4 | 8.49 | 0.319 | 298 | 14.24 | 0.01 |
| 3/18/2004 | 15:10 | 1 | 13.8 | 8.38 | 0.313 | 242 | 14.6 | 0.01 |
| 4/6/2004 | 12:30 | 1 | 12.3 | 8.83 | 0.325 | 61 | 13.52 | 0.01 |
| 4/26/2004 | 13:40 | 1 | 16.0 | 8.20 | 0.337 | 60 | 16.23 | 0.01 |
| 5/13/2004 | 13:43 | 1 | 14.4 | 7.95 | 0.338 | 120 | 13.34 | 0.01 |
| 5/25/2004 | 14:00 | 1 | 15.6 | 7.74 | 0.331 | 187 | 12.34 | 0.01 |
| 6/16/2004 | 11:35 | 1 | 14.9 | 8.09 | 0.251 | 9 | 13.15 | 0.00 |
| 7/1/2004 | 12:58 | 1 | 14.9 | 8.21 | 0.256 | 4 | 13.34 | 0.00 |
| 7/13/2004 | 16:11 | 1 | 17.0 | 13.76 | 0.288 | 56 | 14.28 | 0.01 |
| 7/29/2004 | 17:20 | 1 | 16.0 | 8.06 | 0.392 | 5 | 13.27 | 0.01 |
| 8/19/2004 | 12:50 | 1 | 16.2 | 8.30 | 0.328 | 373 | 13.35 | 0.01 |
| 9/2/2004 | 12:40 | 1 | 18.0 | 13.65 | 0.218 | 52 | 14.37 | 0.01 |
| 9/27/2004 | 15:55 | 1 | 20.7 | 8.35 | 0.261 | 10 | 9.86 | 0.01 |
| 10/14/2004 | 16:00 | 1 | 21.6 | 8.30 | 0.340 | 12 | 12.64 | 0.01 |
| 10/28/2004 | 16:05 | 1 | 16.7 | 8.24 | 0.337 | 16 | 10.49 | 0.01 |
| 11/15/2004 | 16:55 | 1 | 14.8 | 8.31 | 0.358 | 32 | 11.16 | 0.01 |
| 12/2/2004 | 15:06 | 1 | 10.9 | 8.44 | 0.455 | 24 | 12.00 | 0.01 |

Notes
NR = Not Reported

**Table A.3b 2004 Lexington Reservoir Effluent Laboratory Results**

| Date | Sample | Total Mercury (ng/L) | Dissolved Mercury (ng/L) | Methylmercury (ng/L) | TSS (mg/L) | DOC (mg/L) | Sulfate as SO4 (mg/L) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 1/12/2004 | 03128-1 | 11.6 | 10.7 | 0.125 | 20 | 3.8 | 58 | 11.2 |
| 1/12/2004 | 03128-1 Replicate | 12.1 | 8.08 | 0.142 | 18 | 3.9 | 56 | 11.2 |
| 1/12/2004 | Mercury blank | 0.6 | 1.07 | NA | NA | NA | NA | NA |
| 3/4/2004 | 03128-2 | 4.21 | 0.28 | 0.045 | 38 | 3.5 | 33 | 10.4 |
| 3/4/2004 | 03128-2 Replicate | 5.18 | 0.25 | 0.045 | 48 | 3.9 | 29 | 10.5 |
| 3/4/2004 | Mercury blank | 0.93 | 1.93 | NA | NA | NA | NA | NA |
| 3/18/2004 | 03128-3 | 9.4 | 10.2 | 0.05 | ND | 4.2 | 60 | 10.5 |
| 3/18/2004 | 03128-3 Replicate | ND | ND | 0.061 | 22 | 6 | 49 | 10.6 |
| 3/18/2004 | Mercury blank | 0.28 | 1.37 | NA | NA | NA | NA | NA |
| 4/6/2004 | 03128-4 | ND | ND | 0.064 | ND | 3.4 | 50 | 10.7 |
| 4/6/2004 | 03128-4 Replicate | ND | ND | 0.045 | ND | 3.8 | 49 | 10.9 |
| 4/6/2004 | Mercury blank | ND | ND | NA | NA | NA | NA | NA |
| 4/26/2004 | 03128-5 | ND | ND | 0.106 | 12 | 3.1 | 54 | 10.5 |
| 4/26/2004 | 03128-5 Replicate | 6.25 | 6.59 | 0.045 | 12 | 3.4 | 50 | 10.6 |
| 4/26/2004 | Mercury blank | 1.01 | 0.5 | NA | NA | NA | NA | NA |
| 5/13/2004 | 03128-6 | 4.8 | 4.1 | 0.057 | ND | 3.3 | 44 | 10.8 |
| 5/13/2004 | 03128-6 Replicate | 5.02 | 4.18 | 0.045 | ND | 3.4 | 59 | 10.9 |
| 5/13/2004 | Mercury blank | 0.98 | 0.91 | NA | NA | NA | NA | NA |
| 5/25/2004 | 03128-7 | 2.72 | 2.4 | 0.17 | ND | 3.8 | 51 | 10.4 |
| 5/25/2004 | 03128-7 Replicate | 2.57 | 2.59 | 0.169 | ND | 3.5 | 50 | 10.4 |
| 5/25/2004 | Mercury blank | 0.96 | 1.01 | NA | NA | NA | NA | NA |
| 6/16/2004 | 03128-8 | 1.94 | 1.36 | 0.32 | ND | 3.5 | 52 | 10.7 |
| 6/16/2004 | 03128-8 Replicate | 1.87 | 1.27 | 0.314 | ND | 3.4 | 53 | 11 |
| 6/16/2004 | Mercury blank | 0.32 | ND | NA | NA | NA | NA | NA |
| 7/1/2004 | 03128-9 | 1.65 | 1.39 | 0.609 | ND | 3.7 | 48 | 10.4 |

**Table A.3b 2004—continued—Lexington Reservoir Effluent Laboratory Results**

| Date | Sample | Total Mercury (ng/L) | Dissolved Mercury (ng/L) | Methylmercury (ng/L) | TSS (mg/L) | DOC (mg/L) | Sulfate as SO4 (mg/L) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 7/1/2004 | 03128-9 Replicate | 1.65 | 1.42 | 0.59 | ND | 3.7 | 46 | 10.4 |
| 7/1/2004 | Mercury blank | 0.29 | ND | NA | NA | NA | NA | NA |
| 7/13/2004 | 03128-10 | 2.04 | 1.98 | 0.863 | ND | 3.3 | 48 | 10.1 |
| 7/13/2004 | 03128-10 Replicate | 20.1 | 1.66 | 0.787 | ND | 3.3 | 44 | 10.2 |
| 7/13/2004 | Mercury blank | 0.2 | 0.38 | NA | NA | NA | NA | NA |
| 7/29/2004 | 03128-11 | 2.56 | 0.88 | 1.45 | ND | 3.4 | 45 | 10.4 |
| 7/29/2004 | 03128-11 Replicate | 2.49 | 1.08 | 1.54 | ND | 3.4 | 45 | 10.4 |
| 7/29/2004 | Mercury blank | 0.5 | ND | NA | NA | NA | NA | NA |
| 8/19/2004 | 03128-11 | 4.52 | 1.71 | 2.14 | ND | 3.6 | 44 | 9.85 |
| 8/19/2004 | 03128-11 Replicate | 6.8 | 2.18 | 2.18 | ND | 3.3 | 43 | 9.86 |
| 8/19/2004 | Mercury blank | 1.33 | NR | NA | NA | NA | NA | NA |
| 9/2/2004 | 03128-13 | 3.59 | 1.92 | 2.1 | ND | 4.2 | 42 | 9.37 |
| 9/2/2004 | 03128-13 Replicate | 3.56 | 2.09 | **2.43** | ND | 3.9 | 41 | No data |
| 9/2/2004 | Mercury blank | 0.28 | ND | NA | NA | NA | NA | NA |
| 9/27/2004 | 03331-14 | 1.71 | 0.23 | 0.592 | ND | 3.1 | 59 | 8.81 |
| 9/27/2004 | 03331-14 Replicate | 1.46 | 0.21 | 0.594 | ND | 3 | 58 | 8.79 |
| 9/27/2004 | Mercury blank | ND | NA | NA | NA | NA | NA | NA |
| 10/14/2004 | 03331-15 | 1.8 | 1.2 | 0.219 | ND | 260 | 3 | ND |
| 10/14/2004 | 03331-15 Replicate | 1.5 | 2 | 0.286 | ND | 260 | 3.8 | ND |
| 10/14/2004 | Mercury blank | 0.96 | NA | NA | NA | NA | NA | NA |
| 10/28/2004 | 03128-16 | 1.8 | 0.89 | 0.221 | ND | 5.3 | 55 | 9.83 |

**Table A.3b 2004—continued—Lexington Reservoir Effluent Laboratory Results**

| Date | Sample | Total Mercury (ng/L) | Dissolved Mercury (ng/L) | Methylmercury (ng/L) | TSS (mg/L) | DOC (mg/L) | Sulfate as SO4 (mg/L) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 10/28/2004 | 03128-16 | 1.8 | 0.65 | 0.19 | ND | 2.7 | 56 | 9.89 |
| 10/28/2004 | Replicate Mercury blank | 0.7 | NA | NA | NA | NA | NA | NA |
| 11/15/2004 | 03128-17 | 2.3 | 1.3 | 0.102 | 10 | 3.6 | 64 | 9.99 |
| 11/15/2004 | 03128-17 | 2.4 | 1.6 | 0.097 | 12 | 3.4 | 64 | 10.1 |
| 11/15/2004 | Replicate Mercury blank | 1.3 | NA | NA | NA | NA | NA | NA |
| 12/2/2004 | 03331-18 | 3.3 | 0.63 | 0.094 | ND | 3.6 | 74 | 10.5 |
| 12/2/2004 | 03331-18 | 2.7 | 1.1 | 0.095 | ND | 3.8 | 73 | 10.6 |
| 12/2/2004 | Replicate Mercury blank | ND | NA | NA | NA | NA | NA | NA |

**Table A.3b 2004 – continued – Lexington Reservoir Effluent Laboratory Results**

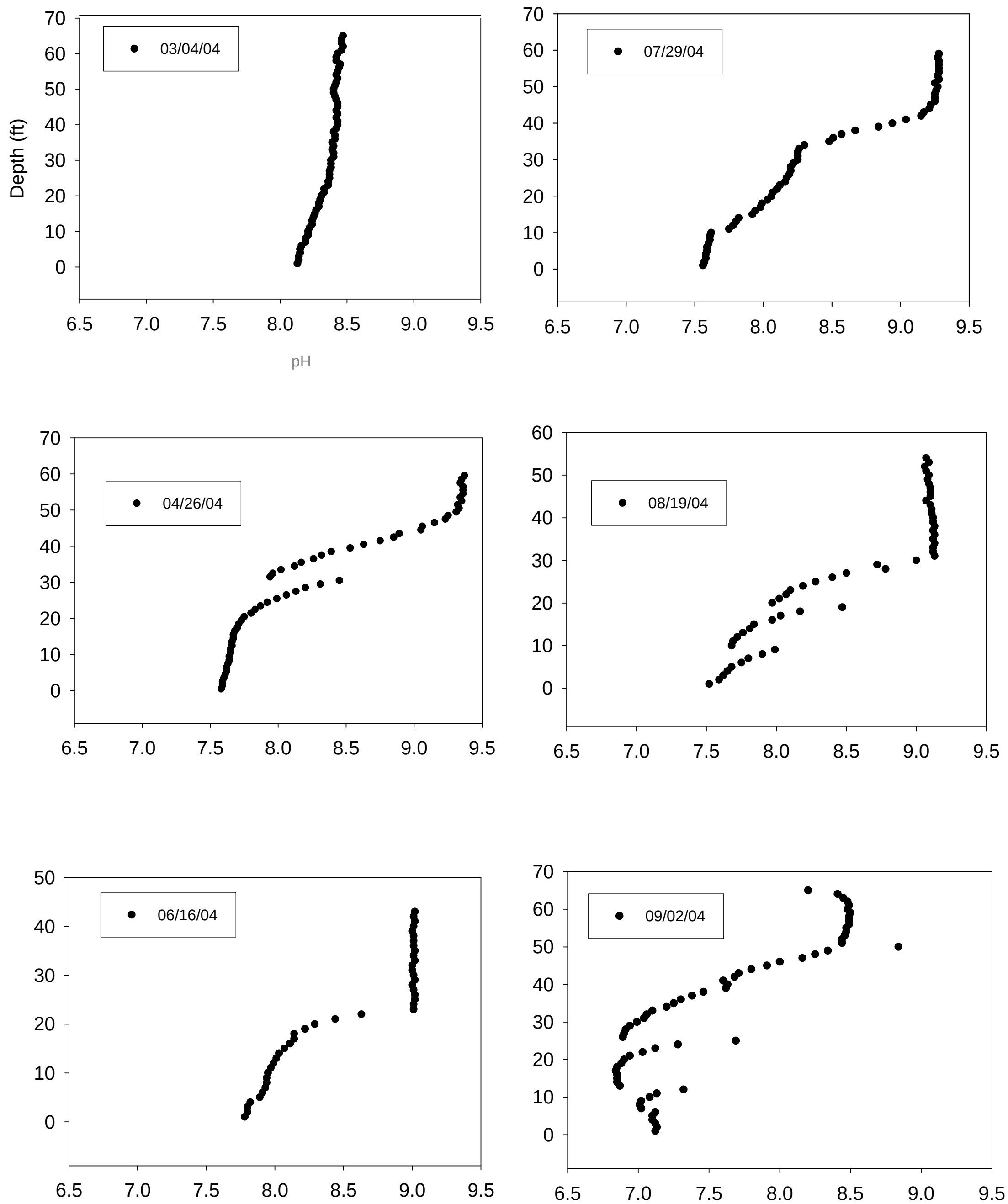
| Date | Sample | Chloride (mg/L) | Total Iron (mg/L) | Dissolved Iron (mg/L) | P (mg/L) | NO2 (mg/L) | NO3 (mg/L) | Fecal coliform (MPN/ 100mL) | TDS (mg/L) | BOD (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/12/04 | 03128-1 | 14 | NR | NR | | | | | | |
| 1/12/04 | 03128-1 Replicate | 11 | NR | NR | | | | | | |
| 1/12/04 | Mercury blank | NA | NA | NA | | | | | | |
| 3/4/04 | 03128-2 | ND | NR | NR | | | | | | |
| 3/4/04 | 03128-2 Replicate | ND | NR | NR | | | | | | |
| 3/4/04 | Mercury blank | NA | NA | NA | | | | | | |
| 3/18/04 | 03128-3 | ND | NR | NR | | | | | | |
| 3/18/04 | 03128-3 Replicate | ND | NR | NR | | | | | | |
| 3/18/04 | Mercury blank | NA | NA | NA | | | | | | |
| 4/6/04 | 03128-4 | 13 | NR | NR | | | | | | |
| 4/6/04 | 03128-4 Replicate | 13 | NR | NR | | | | | | |

**Table A.3b 2004 – continued – Lexington Reservoir Effluent Laboratory Results**

| Date | Sample | Chloride (mg/L) | Total Iron (mg/L) | Dissolved Iron (mg/L) | P (mg/L) | NO2 (mg/L) | NO3 (mg/L) | Fecal coliform (MPN/ 100mL) | TDS (mg/L) | BOD (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4/6/04 | Mercury blank | NA | NA | NA | | | | | | |
| 4/26/04 | 03128-5 | 10 | NR | NR | | | | | | |
| 4/26/04 | 03128-5 Replicate | 10 | NR | NR | | | | | | |
| 4/26/04 | Mercury blank | NA | NA | NA | | | | | | |
| 5/13/04 | 03128-6 | 11 | NR | NR | | | | | | |
| 5/13/04 | 03128-6 Replicate | 20 | NR | NR | | | | | | |
| 5/13/04 | Mercury blank | NA | NA | NA | | | | | | |
| 5/25/04 | 03128-7 | ND | NR | NR | | | | | | |
| 5/25/04 | 03128-7 Replicate | ND | NR | NR | | | | | | |
| 5/25/04 | Mercury blank | NA | NA | NA | | | | | | |
| 6/16/04 | 03128-8 | 10 | NR | NR | | | | | | |
| 6/16/04 | 03128-8 Replicate | 10 | NR | NR | | | | | | |
| 6/16/04 | Mercury blank | NA | NA | NA | | | | | | |
| 7/1/04 | 03128-9 | ND | NR | NR | | | | | | |
| 7/1/04 | 03128-9 Replicate | ND | NR | NR | | | | | | |
| 7/1/04 | Mercury blank | NA | NA | NA | | | | | | |
| 7/13/04 | 03128-10 | 10 | NR | NR | | | | | | |
| 7/13/04 | 03128-10 Replicate | 12 | NR | NR | | | | | | |
| 7/13/04 | Mercury blank | NA | NA | NA | | | | | | |
| 7/29/04 | 03128-11 | 13 | NR | NR | | | | | | |
| 7/29/04 | 03128-11 Replicate | 14 | NR | NR | | | | | | |
| 7/29/04 | Mercury blank | NA | NA | NA | | | | | | |
| 8/19/04 | 03128-11 | 13 | NR | NR | | | | | | |
| 8/19/04 | 03128-11 Replicate | 13 | NR | NR | | | | | | |

**Table A.3b 2004 – continued – Lexington Reservoir Effluent Laboratory Results**

| Date | Sample | Chloride (mg/L) | Total Iron (mg/L) | Dissolved Iron (mg/L) | P (mg/L) | NO2 (mg/L) | NO3 (mg/L) | Fecal coliform (MPN/ 100mL) | TDS (mg/L) | BOD (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/19/04 | Mercury blank | NA | NA | NA | | | | | | |
| 9/2/04 | 03128-13 | 15 | NR | NR | | | | | | |
| 9/2/04 | 03128-13 Replicate | 14 | NR | NR | | | | | | |
| 9/2/04 | Mercury blank | NA | NA | NA | | | | | | |
| 9/27/04 | 03331-14 | 10 | | | 0.02 | ND | ND | ND | 240 | ND |
| 9/27/04 | 03331-14 Replicate | 10 | | | 0.032 | ND | ND | ND | 250 | ND |
| 9/27/04 | Mercury blank | NA | | | NA | NA | NA | NA | NA | NA |
| 10/14/04 | 03331-15 | 56 | 9.28 | 15 | 0.019 | ND | ND | ND | | |
| 10/14/04 | 03331-15 Replicate | 56 | 9.24 | 15 | 0.02 | ND | ND | ND | | |
| 10/14/04 | Mercury blank | NA | NA | NA | NA | NA | NA | NA | | |
| 10/28/04 | 03128-16 | 14 | | | 0.015 | ND | ND | 130 | 230 | ND |
| 10/28/04 | 03128-16 Replicate | 14 | | | 0.012 | ND | ND | 240 | 230 | ND |
| 10/28/04 | Mercury blank | NA | | | NA | NA | NA | NA | NA | NA |
| 11/15/04 | 03128-17 | 18 | | | 0.029 | ND | 5.1 | 17 | 260 | ND |
| 11/15/04 | 03128-17 Replicate | 15 | | | 0.049 | ND | ND | 17 | 260 | ND |
| 11/15/04 | Mercury blank | NA | | | NA | NA | NA | NA | NA | NA |
| 12/2/04 | 03331-18 | 12 | NR | NR | | | | | | |
| 12/2/04 | 03331-18 Replicate | 12 | NR | NR | | | | | | |
| 12/2/04 | Mercury blank | NA | NR | NR | | | | | | |




2. Figure A.3c Lexington Reservoir pH Depth Profiles (2004)

## Table A.4 Silica-Carbonate Soil Mercury Concentrations

| | Sample ID | Total Mercury (ppm) | Percent Passing 2mm Sieve | Comments |
|---|---|---|---|---|
| Non-Mining in Silica-Carbonate | | | | |
| Area: CR-2 | | | | CR-2 Native road base of Franciscan greenstone and silica-carbonate rock colluvium unaffected by mining. Presence of Silica-carbonate rock colluvium was noted in subareas 6 through 15. (Page A-9) Subareas 1 – 10 are mostly in greenstones. (Page 26) |
| Individual Subarea Samples | CR2.11.1 | 32 | 32% | |
| | CR2.12.1 | 32 | 38% | |
| | CR2.13.1 | 22 | 40% | |
| | CR2.14.1 | 38 | 24% | |
| | CR2.15.1 | 22 | 45% | |
| (duplicate) | CR20.15.1 | 18 | 41% | |
| Area: CO-3 | | | | CO-3 Silica-carbonate rock colluvium along a road cut in an unmined area. On the south cut face of the Mine Hill trail, northwestern Mine Hill area, adjacent to the south St. George tunnel. Randomly generated subarea sample locations mostly fell in undisturbed hillslope colluvium above the road cut face, but a few points also fell on the cut face or at ts toe along the road edge. Purpose: Assess the mercury concentrations of colluvium over silica-carbonate rock in an area undisturbed by surface mining activities. |
| Area Composite Aliquots | CO-3A | 19 | 33% | |
| | CO-3B | 20 | 33% | |
| | CO-3C | 17 | 33% | |
| Individual Subarea Samples | CO3.01.1 | 24 | 40% | |
| (duplicate) | CO30.01.1 | 23 | 36% | |
| | CO3.02.1 | 12 | 27% | |
| | CO3.03.1 | 33 | 27% | |
| | CO3.04.1 | 28 | 18% | |
| | CO3.05.1 | 19 | 50% | |
| | CO3.06.1 | 23 | 40% | |
| | CO3.07.1 | 24 | 17% | |
| | CO3.08.1 | 42 | 23% | |
| | CO3.09.1 | 38 | 17% | |
| | CO3.10.1 | 27 | 16% | |
| | CO3.11.1 | 42 | 26% | |
| | CO3.12.1 | 24 | 31% | |
| | CO3.13.1 | 18 | 45% | |
| | CO3.14.1 | 25 | 64% | |
| | CO3.15.1 | 3.2 | 55% | |
| | CO30.15.1 | 2.7 | 60% | |
| count (n) | | 26 | | |
| min | | 2.7 | | |
| median | | 24 | | |
| mean | | 24 | | |
| max | | 42 | | |

**Table A.5 Non-Silica-Carbonate Soil Mercury Concentrations**

| | Sample ID | Total Mercury (ppm) | Percent Passing 2mm Sieve | Comments |
|---|---|---|---|---|
| Non-Mining, Non-Silica-Carbonate | | | | |
| Area: CR-2 | | | | CR-2 Native road base of Franciscan greenstone and silica-carbonate rock colluvium unaffected by mining. Presence of Silica-carbonate rock colluvium was noted in subareas 6 through 15. (Page A-9) Subareas 1 – 10 are mostly in greenstones. (Page 26) |
| Individual Subarea Samples | CR2.01.1 | 3.1 | 54% | |
| (duplicate) | CR20.01.1 | 2.3 | 40% | |
| | CR2.02.1 | 3.4 | 37% | |
| | CR2.03.1 | 1.7 | 41% | |
| | CR2.04.1 | 1.3 | 39% | |
| | CR2.05.1 | 1.3 | 42% | |
| | CR2.06.1 | 3.9 | 47% | |
| | CR2.07.1 | 4.8 | 47% | |
| | CR2.08.1 | 4.4 | 56% | |
| | CR2.09.1 | 7.7 | 44% | |
| | CR2.10.1 | 7.7 | 61% | |
| Area: CR-4 | | | | CR-4: Road base of Franciscan greenstone and serpentine colluvium, unaffected by mining activity. Mine Hill Trail east of the Guadalupe Dam and the San Antonio Mine. The sampled segment is not shown on published maps compiled before 1957, but it is shown on maps prepared for the New Idria Mining and Chemical Company in 1968. |
| Area Composite Aliquots | CR-4A | 0.51 | 48% | |
| | CR-4B | 0.58 | 48% | |
| | CR-4C | 0.93 | 48% | |
| Individual Subarea Samples | CR4.01.1 | 1.2 | 45% | |
| (duplicate) | CR40.01.1 | 1.2 | 46% | |
| | CR4.02.1 | 1.1 | 38% | |
| | CR4.03.1 | 1.4 | 49% | |
| | CR4.04.1 | 0.67 | 45% | |
| | CR4.05.1 | 0.73 | 49% | |
| | CR4.06.1 | 0.72 | 63% | |
| | CR4.07.1 | 0.40 | 48% | |
| | CR4.08.1 | 0.46 | 50% | |
| | CR4.09.1 | 0.68 | 51% | |
| | CR4.10.1 | 0.68 | 54% | |
| | CR4.11.1 | 0.49 | 54% | |
| | CR4.12.1 | 0.49 | 42% | |
| | CR4.13.1 | 0.44 | 46% | |
| | CR4.14.1 | 0.41 | 41% | |
| | CR4.15.1 | 0.75 | 41% | |
| (duplicate) | CR40.15.1 | 0.54 | 54% | |

## Table A.5 Non-Silica-Carbonate Soil Mercury Concentrations

| | Sample ID | Total Mercury (ppm) | Percent Passing 2mm Sieve | Comments |
|---|---|---|---|---|
| Non-Mining, Non-Silica-Carbonate | | | | |
| Area: CO-6 | | | | CO-6: Undisturbed colluvium overlying a typically non-mineralized rock type. Hillside north of Randol Trail and south of the Webb Canyon water tank at the north central Park boundary. CO-6 is about a 20 foot by 100 foot strip located on an undisturbed hillslope near the west end of the Randol Trail. The area is underlain by Franciscan sandstone, but the colluvium is also mixed with chert wasting from a chert-supported knoll upslope. |
| Area Composite Aliquots | CO-6A | 0.20 | 27% | |
| | CO-6B | 0.12 | 27% | |
| | CO-6C | 0.15 | 27% | |
| Individual Subarea Samples | CO6.01.1 | 0.15 | 36% | |
| (duplicate) | CO60.01.1 | 0.11 | 9% | |
| | CO6.02.1 | 0.30 | 32% | |
| | CO6.03.1 | 0.23 | 38% | |
| | CO6.04.1 | 0.27 | 29% | |
| | CO6.05.1 | 0.27 | 29% | |
| | CO6.06.1 | 0.26 | 16% | |
| | CO6.07.1 | 0.21 | 16% | |
| | CO6.08.1 | 0.09 | 31% | |
| | CO6.09.1 | 0.07 | 30% | |
| | CO6.10.1 | 0.17 | 32% | |
| | CO6.11.1 | 0.10 | 23% | |
| | CO6.12.1 | 0.08 | 26% | |
| | CO6.13.1 | 0.15 | 19% | |
| | CO6.14.1 | 0.07 | 23% | |
| | CO6.15.1 | 0.25 | 28% | |
| (duplicate) | CO60.15.1 | 0.28 | 31% | |
| Area: IS-6 | | | | IS-6: Creek sediment unaffected by mining. …location drains a small basin of 36 planimetric acres. The creek received some drainage from park trails, but the trails are based with native colluvium. Franciscan sandstone is the principal rock type in the sediments, with little exception.Organic debris typically covers the sediments. This debris was carefully removed to facilitate sampling of the underlying sediments. |
| Area Composite Aliquots | IS-6A | 1.1 | 25% | |
| | IS-6B | 1.1 | 25% | |
| | IS-6C | 1.1 | 25% | |
| Individual Subarea Samples | IS6.01.1 | 1.9 | 13% | |
| (duplicate) | IS60.01.1 | 1.4 | 20% | |
| | IS6.02.1 | 0.84 | 29% | |
| | IS6.03.1 | 1.1 | 22% | |
| | IS6.04.1 | 1.3 | 49% | |
| | IS6.05.1 | 0.67 | 10% | |
| | IS6.06.1 | 1.1 | 29% | |
| | IS6.07.1 | 1.6 | 54% | |
| | IS6.08.1 | 1.2 | 59% | |
| | IS6.09.1 | 0.94 | 17% | |
| | IS6.10.1 | 1.8 | 36% | |
| | IS6.11.1 | 0.62 | 14% | |
| | IS6.12.1 | 0.32 | 5% | |

## Table A.5 Non-Silica-Carbonate Soil Mercury Concentrations

| | Sample ID | Total Mercury (ppm) | Percent Passing 2mm Sieve | Comments |
|---|---|---|---|---|
| Non-Mining, Non-Silica-Carbonate | | | | |
| (duplicate) | IS60.12.1 | 0.23 | 8% | |
| | IS6.13.1 | 1.6 | 40% | |
| | IS6.14.1 | 0.72 | 30% | |
| | IS6.15.1 | 1.7 | 31% | |
| | IS6.16.1 | 0.74 | 28% | |
| | IS6.17.1 | 0.9 | 8% | |
| | IS6.18.1 | 1.1 | 27% | |
| | IS6.19.1 | 1.5 | 39% | |
| | IS6.20.1 | 1.3 | 24% | |
| | IS6.21.1 | 1.3 | 22% | |
| | IS6.22.1 | 0.87 | 20% | |
| | IS6.23.1 | 0.97 | 32% | |
| | IS6.24.1 | 1.3 | 26% | |
| (duplicate) | IS60.24.1 | 1.6 | 26% | |
| | IS6.25.1 | 1.1 | 27% | |
| | IS6.26.1 | 1.5 | 49% | |
| | IS6.27.1 | 1.3 | 20% | |
| | IS6.28.1 | 0.84 | 15% | |
| | IS6.29.1 | 0.81 | 16% | |
| | IS6.30.1 | 1.3 | 14% | |
| | IS6.31.1 | 0.87 | 21% | |
| | IS6.32.1 | 1.4 | 19% | |
| | IS6.33.1 | 0.72 | 10% | |
| | IS6.34.1 | 0.86 | 20% | |
| | IS6.35.1 | 0.8 | 21% | |
| | IS6.36.1 | 0.71 | 21% | |
| (duplicate) | IS60.36.1 | 0.72 | 27% | |
| count (n) | | 94 | | |
| min | | 0.07 | | |
| median | | 0.84 | | |
| mean | | 1.1 | | |
| max | | 7.7 | | |

**Table A.6 Methylmercury Concentrations in Three Reservoirs**

| | | | T MeHg Hypolimnion (ng/L) measured at outlet | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | Julian Day 2004 | Guadalupe Reservoir | Almaden Reservoir | Lexington Reservoir |
| E7-3a | 5/11/2004 | 130 | 0.853 | | |
| E7-3b | 5/11/2004 | 130 | 0.972 | | |
| E7-3 | 6/10/2004 | 159 | 1.240 | | |
| E7-3 | 7/15/2004 | 194 | 1.540 | | |
| E7-3 | 8/2/2004 | 211 | 6.430 | | |
| E7-3 | 8/12/2004 | 221 | 8.100 | | |
| E7-3 | 8/31/2004 | 240 | 12.80 | | |
| E7-6 | 5/11/2004 | 130 | | 2.271 | |
| E7-6a | 6/10/2004 | 159 | | 2.771 | |
| E7-6b | 6/10/2004 | 159 | | 2.909 | |
| E7-6 | 7/15/2004 | 194 | | 4.720 | |
| E7-6 | 8/2/2004 | 211 | | 4.150 | |
| E7-6 | 8/12/2004 | 221 | | 7.200 | |
| E7-6 | 8/31/2004 | 240 | | 6.47 | |
| A | 5/13/2004 | 132 | | | 0.051 |
| A | 5/25/2004 | 144 | | | 0.17 |
| A | 6/16/2004 | 165 | | | 0.31 |
| A | 7/1/2004 | 180 | | | 0.6 |
| A | 7/13/2004 | 192 | | | 0.825 |
| A | 7/29/2004 | 208 | | | 1.5 |
| A | 8/19/2004 | 228 | | | 2.16 |

## Table A.7a Lexington Reservoir Fish Mercury Concentration Summary (2006)

| | | Total Mercury Concentrations (mg/kg, wet wt) | | | | | Fish Length (total, mm) | | | | | Tissue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | n | Min | Mean | Max | Std Dev | Coef Var | Min | Mean | Max | Std Dev | Coef Var | |
| Adult Largemouth Bass | 15 | 0.37 | 0.58 | 0.92 | 0.17 | 0.29 | 369 | 405 | 512 | 42 | 0.10 | Muscle |
| Pumpkinseed | 5 | 0.055 | 0.13 | 0.24 | 0.085 | 0.64 | 124 | 134 | 147 | 11 | 0.080 | Muscle |
| Inland Silverside | 15 | 0.053 | 0.092 | 0.21 | 0.046 | 0.50 | 103 | 105 | 111 | 3 | 0.026 | Whole |
| Threadfin Shad | 15 | 0.039 | 0.074 | 0.10 | 0.018 | 0.24 | 56 | 88 | 120 | 16 | 0.18 | Whole |

Note Table A.7a: Inland silverside length is fork length.

## Table A.7b Guadalupe Reservoir Fish Mercury Concentration Summary (2006)

| | | Total Mercury Concentrations (mg/kg wet wt) | | | | | Fish Length (total mm) | | | | | Tissue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | n | Min | Mean | Max | Std Dev | Coef Var | Min | Mean | Max | Std Dev | Coef Var | |
| Adult Largemouth Bass | 15 | 2.9 | 7.1 | 13 | 4.0 | 0.56 | 312 | 423 | 543 | 80 | 0.19 | Muscle |
| Age-1 Largemouth Bass | 15 | 0.43 | 1.1 | 1.5 | 0.26 | 0.24 | 72 | 82 | 94 | 5.4 | 0.07 | Whole |

## Table A.7c Hatchery Trout Mercury Concentration Summary (2006)

| | | Total Mercury Concentrations (mg/kg wet wt) | | | | | Fish Length (total mm) | | | | | Tissue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | n | Min | Mean | Max | Std Dev | Coef Var | Min | Mean | Max | Std Dev | Coef Var | |
| Trout | 15 | 0.024 | 0.031 | 0.049 | 0.0066 | 0.21 | 242 | 337 | 416 | 48 | 0.14 | Muscle |

Notes Tables A.7a-c:
n = sample size
Coefficient of Variation = (Standard Deviation) / (Mean)
Muscle = Muscle Tissue Skin Off
Whole = Whole Body (Eviscerated)

## Table A.8a Summary of Adult Largemouth Bass Mercury Data (2004)

Citation: Table 8-1 in *Data Collection Report* (Tetra Tech 2005a)

| | | Total Mercury Concentrations (mg/kg wet) | | | | Total Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Waterbody | Sample Size | Average | Min. | Max. | Coefficient of Variation | Average | Min. | Max. | Coefficient of Variation |
| Guadalupe Reservoir | 18 | 6.1 | 3.1 | 13 | 0.40 | 41.8 | 30.7 | 53.2 | 0.18 |
| Almaden Reservoir | 20 | 4.3 | 2.2 | 7.4 | 0.30 | 43.9 | 33.8 | 51.2 | 0.11 |
| Lake Almaden | 20 | 2.3 | 1.1 | 3.8 | 0.34 | 41.8 | 31.2 | 53.2 | 0.16 |
| Calero Reservoir | 20 | 1.1 | 0.8 | 1.6 | 0.16 | 36.7 | 29.7 | 47.7 | 0.12 |
| Lexington Reservoir | 11 | 0.6 | 0.4 | 1.0 | 0.27 | 40.8 | 35.8 | 50.2 | 0.12 |

## Table A.8b Summary of Age-1 Largemouth Bass Mercury Data (2004)

Citation: Table 8-4 in *Data Collection Report* (Tetra Tech 2005a)

| | | Total Mercury Concentrations (mg/kg wet) | | | | Total Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Waterbody | Sample Size | Average | Min. | Max. | Coefficient of Variation | Average | Min. | Max. | Coefficient of Variation |
| Guadalupe Reservoir | 20 | 0.83 | 0.64 | 1.11 | 0.17 | 9.0 | 7.7 | 9.7 | 0.07 |
| Almaden Reservoir | 20 | 0.96 | 0.58 | 1.53 | 0.29 | 6.9 | 5.6 | 8.2 | 0.10 |
| Lake Almaden | 20 | 0.39 | 0.21 | 0.53 | 0.22 | 9.3 | 8.0 | 10.2 | 0.08 |
| Calero Reservoir | 20 | 0.21 | 0.10 | 0.58 | 0.53 | 7.4 | 5.5 | 10.2 | 0.22 |
| Lexington Reservoir | 20 | 0.09 | 0.06 | 0.14 | 0.22 | 8.9 | 7.1 | 10.2 | 0.10 |

## Table A.8c Summary of California Roach Mercury Data (2004)

Citation: Table 8-5 in *Data Collection Report* (Tetra Tech 2005a)

| | | | Total Mercury Concentrations (mg/kg wet) | | | |
|---|---|---|---|---|---|---|
| Site Number | Waterbody and Location | Sample Size | Average | Min. | Max. | Coefficient of Variation |
| 1 | Guadalupe R., at Foxworthy Ave. | 9 | 0.15 | 0.12 | 0.19 | 0.17 |
| 2 | Guadalupe R., at Coleman Ave. | 25 | 0.08 | 0.04 | 0.12 | 0.32 |
| 4 | Guadalupe Creek, at Meridian Ave. | 20 | 0.39 | 0.31 | 0.48 | 0.11 |
| 5 | Alamitos Creek, at Harry Road | 20 | 0.28 | 0.20 | 0.41 | 0.21 |
| 6 | Alamitos Creek, at Greystone Lane | 20 | 0.15 | 0.10 | 0.26 | 0.26 |
| 9 | Los Gatos Creek, at Linclon Ave. | 20 | 0.03 | 0.02 | 0.04 | 0.24 |

## Table A.9 2003 Summary of Guadalupe Reservoir Fish Mercury Concentrations (2003)

| | | Total Mercury Concentrations (mg/kg wet wt) | | | | | Fish Length (mm) | | | | | Tissue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | n | Min | Mean | Max | Std Dev | Coef Var | Min | Mean | Max | Std Dev | Coef Var | |
| Adult Largemouth bass | 15 | 2.6 | 4.0 | 5.8 | 0.9 | 0.22 | 273 | 374 | 505 | 56 | 0.15 | Muscle |
| Black Crappie | 11 | 1.7 | 2.0 | 2.9 | 0.34 | 0.17 | 130 | 166 | 275 | 38 | 0.23 | Muscle |

Notes Table A.9:
Fish length not specified fork or total
n = sample size
Coefficient of Variation = (Standard Deviation) / (Mean)
Muscle = Muscle Tissue Skin Off
Whole = Whole Body (Eviscerated)

## Table A.10 Fish Mercury Concentrations in Almaden Reservoir and Lake Almaden

| DATE | SPECIES | LENGTH (cm) | WEIGHT (g) | Mercury (mg/kg, ww) |
|---|---|---|---|---|
| **ALMADEN RESERVOIR** | | | | |
| Nov-70 | Black Bass | | | 1.0 |
| Nov-70 | Black Bass | | | 2.7 |
| Nov-70 | Black Bass | | | 3.6 |
| Nov-70 | Goldfish | | | 0.83 |
| Nov-70 | Goldfish | | | 2.1 |
| Nov-70 | Red Ear Sunfish | | | 0.52 |
| Nov-70 | Red Ear Sunfish | | | 0.63 |
| 7/1/87 | Bullhead | | | 0.21 |
| 7/1/87 | Bullhead | | | 0.26 |
| 7/1/87 | Bullhead | | | 0.33 |
| 7/1/87 | Bullhead | | | 0.33 |
| 7/1/87 | Bullhead | | | 0.40 |
| 7/1/87 | Bullhead | | | 0.53 |
| 7/1/87 | Bullhead | | | 0.54 |
| 7/1/87 | Bullhead | | | 0.66 |
| 7/1/87 | Bullhead | | | 0.75 |
| 7/1/87 | Bullhead | | | 0.85 |
| 7/1/87 | Bullhead | | | 0.88 |
| 7/1/87 | Rainbow Trout | | | 0.39 |
| 7/1/87 | Rainbow Trout | | | 0.43 |
| 7/1/87 | Rainbow Trout | | | 0.44 |

**Table A.10 Fish Mercury Concentrations in Almaden Reservoir and Lake Almaden**

| DATE | SPECIES | LENGTH (cm) | WEIGHT (g) | Mercury (mg/kg, ww) |
|---|---|---|---|---|
| 7/1/87 | Rainbow Trout | | | 0.45 |
| 7/1/87 | Rainbow Trout | | | 0.52 |
| 7/1/87 | Rainbow Trout | | | 0.53 |
| 7/1/87 | Rainbow Trout | | | 0.55 |
| 7/1/87 | Rainbow Trout | | | 0.56 |
| 9/1/2004 | Largemouth bass | 330 | 520 | 2.16 |
| 9/1/2004 | Largemouth bass | 400 | 1060 | 2.52 |
| 9/1/2004 | Largemouth bass | 330 | 540 | 2.52 |
| 9/1/2004 | Largemouth bass | 370 | 840 | 3.08 |
| 9/1/2004 | Largemouth bass | 430 | 1480 | 3.30 |
| 9/1/2004 | Largemouth bass | 450 | 1660 | 3.52 |
| 9/1/2004 | Largemouth bass | 420 | 1030 | 3.57 |
| 9/1/2004 | Largemouth bass | 490 | 1900 | 3.78 |
| 9/1/2004 | Largemouth bass | 395 | 1070 | 3.96 |
| 9/1/2004 | Largemouth bass | 460 | 1930 | 4.62 |
| 9/1/2004 | Largemouth bass | 440 | 1370 | 4.84 |
| 9/1/2004 | Largemouth bass | 450 | 1680 | 5.04 |
| 9/1/2004 | Largemouth bass | 435 | 1700 | 5.04 |
| 9/1/2004 | Largemouth bass | 435 | 1520 | 5.06 |
| 9/1/2004 | Largemouth bass | 460 | 1670 | 5.06 |
| 9/1/2004 | Largemouth bass | 425 | 1230 | 5.25 |
| 9/1/2004 | Largemouth bass | 500 | 2080 | 5.28 |

## Table A.10 Fish Mercury Concentrations in Almaden Reservoir and Lake Almaden

| DATE | SPECIES | LENGTH (cm) | WEIGHT (g) | Mercury (mg/kg, ww) |
|---|---|---|---|---|
| 9/1/2004 | Largemouth bass | 430 | 1230 | 5.46 |
| 9/1/2004 | Largemouth bass | 455 | 1430 | 5.50 |
| 9/1/2004 | Largemouth bass | 465 | 1590 | 7.35 |
| **LAKE ALMADEN** | | | | |
| 8/31/2004 | Largemouth bass | 305 | 490 | 1.10 |
| 8/31/2004 | Largemouth bass | 315 | 530 | 1.17 |
| 8/31/2004 | Largemouth bass | 320 | 510 | 1.20 |
| 8/31/2004 | Largemouth bass | 365 | 820 | 1.50 |
| 8/31/2004 | Largemouth bass | 390 | 1020 | 1.74 |
| 8/31/2004 | Largemouth bass | 365 | 790 | 1.85 |
| 8/31/2004 | Largemouth bass | 420 | 1240 | 1.93 |
| 8/31/2004 | Largemouth bass | 400 | 1020 | 1.94 |
| 8/31/2004 | Largemouth bass | 350 | 810 | 1.96 |
| 8/31/2004 | Largemouth bass | 350 | 660 | 2.10 |
| 8/31/2004 | Largemouth bass | 500 | 2320 | 2.31 |
| 8/31/2004 | Largemouth bass | 465 | 1650 | 2.40 |
| 8/31/2004 | Largemouth bass | 395 | 1060 | 2.40 |
| 8/31/2004 | Largemouth bass | 440 | 1390 | 2.52 |
| 8/31/2004 | Largemouth bass | 445 | 1530 | 2.73 |
| 8/31/2004 | Largemouth bass | 400 | 1000 | 2.86 |
| 8/31/2004 | Largemouth bass | 455 | 1880 | 3.08 |
| 8/31/2004 | Largemouth bass | 480 | 1830 | 3.30 |
| 8/31/2004 | Largemouth bass | 480 | 2220 | 3.57 |
| 8/31/2004 | Largemouth bass | 520 | 2380 | 3.78 |

# APPENDIX B – CALCULATIONS



## Calculation B.1 Bioaccumulation Factors (BAFs)

In Table B.1a on the following pages we provide the 2004 surface, depth profile, and discharge point methylmercury concentrations used to develop the BAFs. In the following two tables, Tables B.1b and B.1c, we provide the 2004 fish mercury concentrations and BAFs for adult largemouth bass and age-1 largemouth bass, respectively. Also in Table B.1c, we provide the BAFs for threadfin shad and inland silversides (TL3 fish 50-150mm in length) collected in 2006 from Lexington Reservoir.

## Table B.1a Methylmercury Concentrations Used to Calculate Bioaccumulation Factors (BAFs)

| | | | Surface | | | Hypolimnion (true) | | | Hypolimnion (discharge point) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | Dissolved | Depth | Total | Dissolved | Dissolved | Total | Dissolved | Dissolved |
| | Sample Date | Sample ID | MeHg (ng/l) | MeHg (ng/l) | (ft) | MeHg (ng/l) | MeHg (ng/l) | % | MeHg (ng/l) | MeHg (ng/l) | % |
| **Guadalupe Reservoir** | | | | | | | | | | | |
| (Tetra Tech 2003) | | | | | | | | | | | |
| Table 3-2 | 7/31/2003 | Site 19B | | | 40 | 2.91 | 0.743 | 26% | | | |
| Table 3-3 | 7/31/2003 | Site 11 | | | | | | | 8.27 | 6.073 | 73% |
| Table 3-2 | 7/31/2003 | Site 19T | 3.31 | 0.491 | | | | | | | |
| " | 7/31/2003 | Site 20 | 4.62 | 0.744 | | | | | | | |
| " | 7/31/2003 | Site 20V | 1.00 | 0.595 | | | | | | | |
| (Tetra Tech 2005a) | | | | | | | | | | | |
| Table 4-3 | 5/11/2004 | | 0.566 | 0.171 | 50 | 0.463 | 0.247 | 53% | 0.853 | 0.552 | 65% |
| | 6/10/2004 | | 0.472 | 0.157 | 50 | 0.424 | 0.226 | 53% | 1.240 | 0.772 | 62% |
| | 7/15/2004 | | 0.299 | 0.123 | 50 | 0.965 | 0.802 | 83% | 1.540 | 1.010 | 66% |
| | 7/15/2004 | | 0.267 | 0.117 | | | | | | | |
| | 8/2/2004 | | 0.204 | 0.128 | 50 | 3.810 | 3.58 | 94% | 6.430 | 3.73 | 58% |
| | 8/12/2004 | | 0.324 | 0.117 | 50 | 11.000 | 8.27 | 75% | 8.100 | 6.08 | 75% |
| | 8/12/2004 | | | | 50 | 5.090 | 5.47 | 107% | | | |
| | 8/31/2004 | | 0.272 | 0.085 | 50 | 11.5 | 7.2 | 63% | 12.80 | 7.24 | 57% |
| | 9/18/2004 | | | | | | | | | | |
| Average methylmercury 2003-2004: | | | 1.13 | 0.27 | | 4.52 | 3.32 | | 5.60 | 3.64 | |
| Peak methylmercury on Sep. 18, 2004: | | | | | | 10.73 | 8.17 | | 11.82 | 7.29 | |
| % dissolved methylmercury | | | | | | | | 26% | | | 57% |
| mean | | | | | | | | 69% | | | 65% |
| max | | | | | | | | 107% | | | 75% |

**Table B.1a - continued**

| | Sample Date | Sample ID | Surface Total MeHg (ng/l) | Surface Dissolved MeHg (ng/l) | Depth (ft) | Hypolimnion (true) Total MeHg (ng/l) | Hypolimnion (true) Dissolved MeHg (ng/l) | Dissolved % | Hypolimnion (discharge point) Total MeHg (ng/l) | Hypolimnion (discharge point) Dissolved MeHg (ng/l) | Dissolved % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Almaden Reservoir** | | | | | | | | | | | |
| (Tetra Tech 2003) | | | | | | | | | | | |
| Table 3-2 | 7/30/2003 | Site 21B | | | 40 | 2.25 | 0.556 | | | | |
| Table 3-3 | 7/30/2003 | Site 1 | | | | | | | 4.34 | 3.78 | |
| Table 3-2 | 7/30/2003 | Site 21T | 2.26 | 0.610 | | | | | | | |
| " | 7/30/2003 | Site 22 | 1.75 | 0.414 | | | | | | | |
| " | 7/30/2003 | Site 22V | 3.26 | 1.06 | | | | | | | |
| (Tetra Tech 2005a) | | | | | | | | | | | |
| Table 4-3 | 5/11/2004 | | 0.336 | 0.164 | 50 | 0.518 | 0.298 | 58% | 2.271 | 1.219 | 54% |
| | 6/10/2004 | | 0.506 | 0.333 | 50 | 1.287 | 0.817 | 63% | 2.771 | 1.584 | 57% |
| | 6/10/2004 | | | | | | | | 2.909 | 1.515 | 52% |
| | 7/15/2004 | | 0.446 | 0.266 | 50 | 2.300 | 1.140 | 50% | 4.720 | 1.110 | 24% |
| | 8/2/2004 | | 0.582 | 0.287 | 50 | 2.070 | 1.07 | 52% | 4.150 | 2.38 | 57% |
| | 8/2/2004 | | 0.511 | 0.233 | | | | | | | |
| | 8/12/2004 | | 0.466 | 0.237 | 50 | 1.830 | 2.81 | 154% | 7.200 | 4.29 | 60% |
| | 8/31/2004 | | 0.369 | 0.277 | 50 | 5.49 | 3.09 | 56% | 6.47 | 3.69 | 57% |
| | 8/31/2004 | | | | 50 | 5.09 | 2.68 | 53% | | | |
| | 9/18/2004 | | | | | | | | | | |
| Average methylmercury 2003-2004: | | | 1.05 | 0.39 | | 2.60 | 1.56 | | 4.35 | 2.45 | |
| Peak methylmercury on Sep. 18, 2004: | | | | | | 4.87 | 3.10 | | 7.40 | 4.03 | |
| % dissolved methylmercury | | | | | | | | 50% | | | 24% |
| mean | | | | | | | | 69% | | | 51% |
| max | | | | | | | | 154% | | | 60% |

## Table B.1a - continued

| | | | Surface | | | Hypolimnion (true) | | | Hypolimnion (discharge point) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | Dissolved | Depth | Total | Dissolved | Dissolved | Total | Dissolved | Dissolved |
| | Sample Date | Sample ID | MeHg (ng/l) | MeHg (ng/l) | (ft) | MeHg (ng/l) | MeHg (ng/l) | % | MeHg (ng/l) | MeHg (ng/l) | % |
| **Calero Reservoir** (Tetra Tech 2003) | | | | | | | | | | | |
| Table 3-2 | 7/30/2003 | Site 23B | | | 40 | 3.05 | 1.25 | 41% | | | |
| Table 3-3 | 7/30/2003 | Site 8 | | | | | | | 2.77 | 1.33 | 48% |
| Table 3-2 | 7/30/2003 | Site 23T | 0.92 | 0.203 | | | | | | | |
| " | 7/30/2003 | Site 23T Rep | 0.77 | 0.083 | | | | | | | |
| " | 7/30/2003 | Site 24 | 1.06 | 0.192 | | | | | | | |
| " | 7/30/2003 | Site 24V | 0.29 | 0.185 | | | | | | | |
| No methylmercury data was collected from Calero Reservoir in 2004 | | | | | | | | | | | |
| **Lake Almaden** (Tetra Tech 2003) | | | | | | | | | | | |
| Table 3-3 | 7/29/2003 | Site 7 | 17.85 | 1.72 | (depth not reported) | | | | | | |
| No methylmercury data was collected from Lake Almaden in 2004 | | | | | | | | | | | |

## Table B.1a - continued

| | | | Surface | | | Hypolimnion (true) | | | Hypolimnion (discharge point) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Total** | **Dissolved** | **Depth** | **Total** | **Dissolved** | **Dissolved** | **Total** | **Dissolved** | **Dissolved** |
| | **Sample Date** | **Sample ID** | **MeHg (ng/l)** | **MeHg (ng/l)** | **(ft)** | **MeHg (ng/l)** | **MeHg (ng/l)** | **%** | **MeHg (ng/l)** | **MeHg (ng/l)** | **%** |
| **Lexington Reservoir** | | | | | | | | | | | |
| (Tetra Tech 2003) | | | | | | | | | | | |
| Table 3-2 | 7/31/2003 | Site 18B | | | 40 | 1.25 | 0.735 | 59% | | | |
| Table 3-3 | 7/31/2003 | Site 16 | | | | | | | 0.756 | 0.745 | 99% |
| Table 3-2 | 7/31/2003 | Site 18T | 0.57 | 0.069 | | | | | | | |
| (LAS 2004) | 1/12/2004 | 03128-1 | | | | | | | 0.125 | | |
| | 1/12/2004 | 03128-1 Replicate | | | | | | | 0.142 | | |
| | 3/4/2004 | 03128-2 | | | | | | | 0.045 | | |
| | 3/4/2004 | 03128-2 Replicate | | | | | | | 0.045 | | |
| | 3/18/2004 | 03128-3 | | | | | | | 0.05 | | |
| | 3/18/2004 | 03128-3 Replicate | | | | | | | 0.061 | | |
| | 4/6/2004 | 03128-4 | | | | | | | 0.064 | | |
| | 4/6/2004 | 03128-4 Replicate | | | | | | | 0.045 | | |
| | 4/26/2004 | 03128-5 | | | | | | | 0.106 | | |
| | 4/26/2004 | 03128-5 Replicate | | | | | | | 0.045 | | |
| | 5/11/2004 | | | | | | | | | | |
| | 5/13/2004 | 03128-6 | | | | | | | 0.057 | | |
| | 5/13/2004 | 03128-6 Replicate | | | | | | | 0.045 | | |
| | 5/25/2004 | 03128-7 | | | | | | | 0.17 | | |
| | 5/25/2004 | 03128-7 Replicate | | | | | | | 0.169 | | |
| | 6/16/2004 | 03128-8 | | | | | | | 0.32 | | |
| | 6/16/2004 | 03128-8 Replicate | | | | | | | 0.314 | | |
| | 7/1/2004 | 03128-9 | | | | | | | 0.609 | | |
| | 7/1/2004 | 03128-9 Replicate | | | | | | | 0.59 | | |

**Table B.1a - continued**

| | | Surface | | | Hypolimnion (true) | | | Hypolimnion (discharge point) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Dissolved | Depth | Total | Dissolved | Dissolved | Total | Dissolved | Dissolved |
| Sample Date | Sample ID | MeHg (ng/l) | MeHg (ng/l) | (ft) | MeHg (ng/l) | MeHg (ng/l) | % | MeHg (ng/l) | MeHg (ng/l) | % |
| **Lexington Reservoir - continued** | | | | | | | | | | |
| 7/13/2004 | 03128-10 | | | | | | | 0.863 | | |
| 7/13/2004 | 03128-10 Replicate | | | | | | | 0.787 | | |
| 7/29/2004 | 03128-11 | | | | | | | 1.45 | | |
| 7/29/2004 | 03128-11 Replicate | | | | | | | 1.54 | | |
| 8/19/2004 | 03128-11 | | | | | | | 2.14 | | |
| 8/19/2004 | 03128-11 Replicate | | | | | | | 2.18 | | |
| 9/2/2004 | 03128-13 | | | | | | | 2.1 | | |
| 9/2/2004 | 03128-13 Replicate | | | | | | | 2.43 | | |
| 9/18/2004 | | | | | | | | | | |
| 9/27/2004 | 03331-14 | | | | | | | 0.592 | | |
| 9/27/2004 | 03331-14 Replicate | | | | | | | 0.594 | | |
| 10/14/2004 | 03331-15 | | | | | | | 0.219 | | |
| 10/14/2004 | 03331-15 Replicate | | | | | | | 0.286 | | |
| 10/28/2004 | 03128-16 | | | | | | | 0.221 | | |
| 10/28/2004 | 03128-16 Replicate | | | | | | | 0.19 | | |
| 11/15/2004 | 03128-17 | | | | | | | 0.102 | | |
| 11/15/2004 | 03128-17 Replicate | | | | | | | 0.097 | | |
| 12/2/2004 | 03331-18 | | | | | | | 0.094 | | |
| 12/2/2004 | 03331-18 Replicate | | | | | | | 0.095 | | |
| | Average methylmercury 2003-2004: | | | | | | | 0.53 | | |
| | Peak methylmercury on Sep. 18, 2004: | | | | | | | 2.6 | | |

## Table B.1b Bioaccumulation Factors for 2004 Adult Largemouth Bass

| | Surface | | Hypolimnion (true) | | Hypolimnion (discharge point) | | Average Fish Tissue |
|---|---|---|---|---|---|---|---|
| | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total Hg (mg/kg ww)** |
| | **MeHg (ng/l)** | **MeHg (ng/l)** | **MeHg (ng/l)** | **MeHg (ng/l)** | **MeHg (ng/l)** | **MeHg (ng/l)** | **2004 Adult Largemouth Bass** |
| **Guadalupe Reservoir** | | | | | | | 6.1 |
| Average methylmercury 2003-2004: | 1.13 | 0.27 | 4.52 | 3.32 | 5.60 | 3.64 | |
| BAF: | 5,400,000 | 22,000,000 | 1,300,000 | 1,800,000 | 1,100,000 | 1,700,000 | |
| Peak methylmercury on Sep. 18, 2004: | | | 10.73 | 8.17 | 11.82 | 7.29 | |
| BAF: | | | 570,000 | 700,000 | 500,000 | 800,000 | |
| **Almaden Reservoir** | | | | | | | 4.3 |
| Average methylmercury 2003-2004: | 1.05 | 0.39 | 2.60 | 1.56 | 4.35 | 2.45 | |
| BAF: | 4,100,000 | 11,000,000 | 1,700,000 | 2,800,000 | 990,000 | 1,800,000 | |
| Peak methylmercury on Sep. 18, 2004: | | | 4.87 | 3.10 | 7.40 | 4.03 | |
| BAF: | | | 880,000 | 1,400,000 | 580,000 | 1,100,000 | |
| **Calero Reservoir** | | | | | | | 1.1 |
| Average methylmercury 2003-2004: | 0.76 | 0.17 | 3.05 | 1.25 | 2.77 | 1.33 | |
| BAF: | 1,400,000 | 6,600,000 | 360,000 | 880,000 | 400,000 | 830,000 | |
| **Lake Almaden** | | | | | | | 2.3 |
| One measurement in 2003: | 17.85 | 1.72 | | | | | |
| BAF: | 130,000 | 1,300,000 | | | | | |

**Table B.1b - continued**

| | Surface | | Hypolimnion (true) | | Hypolimnion (discharge point) | | Average Fish Tissue |
|---|---|---|---|---|---|---|---|
| | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total Hg (mg/kg ww) |
| | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | 2004 Adult Largemouth Bass |
| **Lexington Reservoir** | | | | | | | 0.6 |
| Average methylmercury 2003-2004: | | | | | 0.53 | | |
| BAF: | | | | | 1,100,000 | | |
| Peak methylmercury on Sep. 18, 2004: | | | | | 2.55 | | |
| BAF: | | | | | 240,000 | | |

## Table B.1c Bioaccumulation Factors for 2004 Age-1 Largemouth Bass and 2006 TL3 Species

| | Surface | | Hypolimnion (true) | | Hypolimnion (discharge point) | | Average Fish Tissue Total Hg (mg/kg ww) | Average Fish Tissue Total Hg (mg/kg ww) |
|---|---|---|---|---|---|---|---|---|
| | Total | Dissolved | Total | Dissolved | Total | Dissolved | | |
| | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | MeHg (ng/l) | 2004 Age-1 Largemouth Bass | 2006 TL3 species |
| **Guadalupe Reservoir** | | | | | | | 0.83 | |
| Average methylmercury 2003-2004: | 1.13 | 0.27 | 4.52 | 3.32 | 5.60 | 3.64 | | |
| BAF: | 730,000 | 3,000,000 | 180,000 | 250,000 | 150,000 | 230,000 | | |
| Peak methylmercury on Sep. 18, 2004: | | | 10.73 | 8.17 | 11.82 | 7.29 | | |
| BAF: | | | 77,000 | 100,000 | 70,000 | 110,000 | | |
| **Almaden Reservoir** | | | | | | | 0.96 | |
| Average methylmercury 2003-2004: | 1.05 | 0.39 | 2.60 | 1.56 | 4.35 | 2.45 | | |
| BAF: | 920,000 | 2,500,000 | 370,000 | 620,000 | 220,000 | 390,000 | | |
| Peak methylmercury on Sep. 18, 2004: | | | 4.87 | 3.10 | 7.40 | 4.03 | | |
| BAF: | | | 200,000 | 310,000 | 130,000 | 240,000 | | |
| **Calero Reservoir** | | | | | | | 0.21 | |
| Average methylmercury 2003-2004: | 0.76 | 0.17 | 3.05 | 1.25 | 2.77 | 1.33 | | |
| BAF: | 280,000 | 1,300,000 | 69,000 | 170,000 | 76,000 | 160,000 | | |
| **Lake Almaden** | | | | | | | 0.39 | |
| One measurement in 2003: | 17.85 | 1.72 | | | | | | |
| BAF: | 22,000 | 230,000 | | | | | | |
| **Lexington Reservoir** | | | | | | | 0.09 | 0.083 |
| Average methylmercury 2003-2004: | | | | | 0.53 | | | |
| 2004 Age-1 Largemouth Bass BAF: | | | | | 170,000 | | | |
| 2006 TL3 species BAF: | | | | | 160,000 | | | |
| Peak methylmercury on Sep. 18, 2004: | | | | | 2.55 | | | |
| 2004 Age-1 Largemouth Bass BAF: | | | | | 35,000 | | | |
| 2006 TL3 species BAF: | | | | | 33,000 | | | |

## Table B.1d Adult Largemouth Bass Bioaccumulation Factors

Citation: Table 8-6 in *Data Collection Report* (Tetra Tech 2005a)

| Waterbody | Average Fish Tissue Total Hg *mg/kg wet* | MeHg, ng/L unfiltered Surface | MeHg, ng/L unfiltered Hypolimnion | Log(BAF, L kg-1) Surface | Log(BAF, L kg-1) Hypolimnion |
|---|---|---|---|---|---|
| Guadalupe Reservoir | 5.80 | 0.46 | 5.61 | 7.1 | 6.0 |
| Almaden Reservoir | 3.60 | 0.58 | 4.57 | 6.8 | 5.9 |
| Lake Almaden | 2.10 | 0.30 | - | 6.8 | - |
| Calero Reservoir | 1.20 | 0.24 | 2.77 | 6.7 | 5.6 |
| Lexington Reservoir | 0.60 | 0.20 | 0.76 | 6.5 | 5.9 |

## Table B.1e Age-1 Largemouth Bass Bioaccumulation Factors

Citation: Table 8-7 in *Data Collection Report* (Tetra Tech 2005a)

| Waterbody | Average Fish Tissue Total Hg *mg/kg wet* | MeHg, ng/L unfiltered Surface | MeHg, ng/L unfiltered Hypolimnion | Log(BAF, L kg-1) Surface | Log(BAF, L kg-1) Hypolimnion |
|---|---|---|---|---|---|
| Guadalupe Reservoir | 0.82 | 0.46 | 5.61 | 6.3 | 5.2 |
| Almaden Reservoir | 0.96 | 0.58 | 4.57 | 6.2 | 5.3 |
| Lake Almaden | 0.39 | 0.30 | - | 6.1 | - |
| Calero Reservoir | 0.21 | 0.24 | 2.77 | 5.9 | 4.9 |
| Lexington Reservoir | 0.09 | 0.20 | 0.76 | 5.6 | 5.1 |

## Table B.1f Age-1 Largemouth Bass Bioaccumulation Factors

Citation: Table 8-9 in *Data Collection Report* (Tetra Tech 2005a)

| Site | Waterbody | Fish Total Hg mg/kg wet | Total Hg, ng/L unfiltered | Me Hg, ng/L unfiltered | Log(BAF) (L kg$^{-1}$) | Sed Total Hg (ng/g) | Sed MeHg (ng/g) |
|---|---|---|---|---|---|---|---|
| 1 | Guadalupe R., Foxworthy | 0.15 | 105 | 0.323 | 5.66 | - | - |
| 2 | Guadalupe R., Coleman Ave. | 0.08 | - | - | - | 971 | 1.03 |
| 4 | Guadalupe Crk, Meridian Ave. | 0.39 | 38.9 | 0.990 | 5.60 | 20,369 | 1.29 |
| 5 | Alamitos Crk, Harry Road | 0.28 | 503.2 | 0.886 | 5.50 | 26,586 | 7.29 |
| 6 | Alamitos Crk, Greystone | 0.15 | 25.88 | 0.306 | 5.68 | 18,081 | 0.91 |
| 9 | Los Gatos Crk, Lincoln | 0.03 | 3.2 | 0.037 | 5.83 | 42 | 0.04 |

### *Calculation B.2 Dissolved Mercury as a Percent of Total Mercury*

The sample IDs and calculation of dissolved mercury as a percent of total mercury are presented on the table below.

**Table B.4 Dissolved Mercury as a Percent of Total Mercury**

| **Final Data Collection Report** *(Tetra Tech 2005a)* | | | | **Almaden Quicksilver County Park 2003-2004 Annual Report for Storm Water Discharges Associated with Industrial Activities** *WDID No. 243S006793* *(County Parks 2004)* | | | |
|---|---|---|---|---|---|---|---|
| Table 3-3 | | | | Sample date: February 25, 2004 | | | |
| Sample ID | Total Mercury (ng/L) | Dissolved Mercury (ng/L) | Percent Dissolved | Sample ID | Total Mercury (ng/L) | Dissolved Mercury (ng/L) | Percent Dissolved |
| E1-3 | 8.74 | 1.19 | 14% | Senador | 27 | 0.12 | 0.44% |
| E1-3A | 2.06 | 0.79 | 38% | Mockingbird | 0.39 | 0.046 | 12% |
| E1-3B | 2.03 | 0.59 | 29% | Lower Alamitos | 110 | 0.52 | 0.47% |
| E1-6 | 82.2 | 11.5 | 14% | Jacques Gulch | 0.44 | 0.033 | 7.5% |
| E1-7 | 45.6 | 24.2 | 53% | Los Capitancillos | 5.3 | 0.034 | 0.64% |
| E1-7 | 42.2 | 23.5 | 56% | Landfill Gully | 2.5 | 0.026 | 1.0% |
| E1-9 | 13.4 | 6.57 | 49% | | | | |
| E1-9A | 35.1 | 8.3 | 24% | | | min | 0.44% |
| E1-9B | 18.2 | 6.68 | 37% | | | max | 12% |
| | | min | 14% | | | | |
| | | max | 56% | | | | |

# APPENDIX C – FIGURES

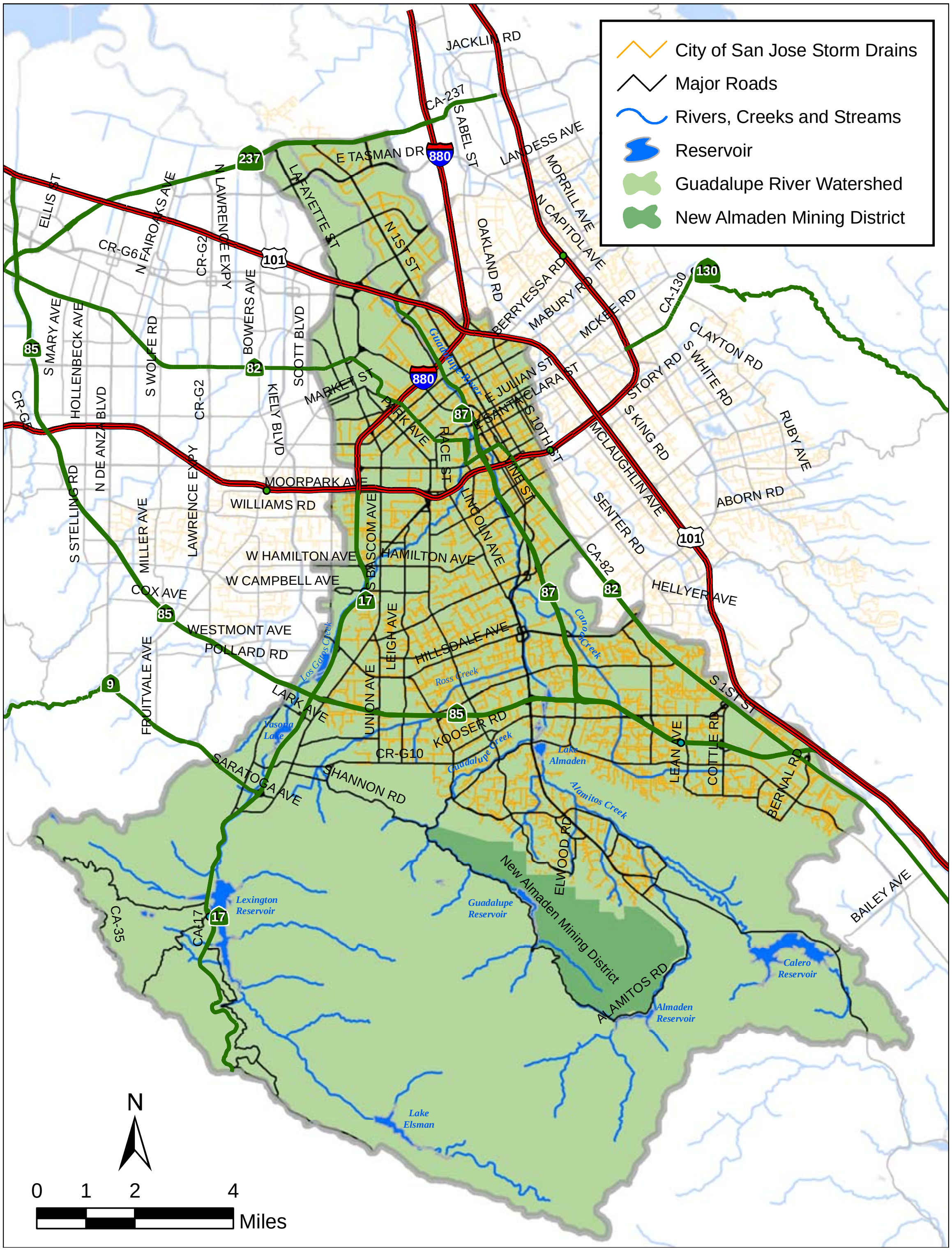



***Figure C.1 Storm Drain Map, Guadalupe River Watershed***

Figure prepared by City of San Jose, 2007

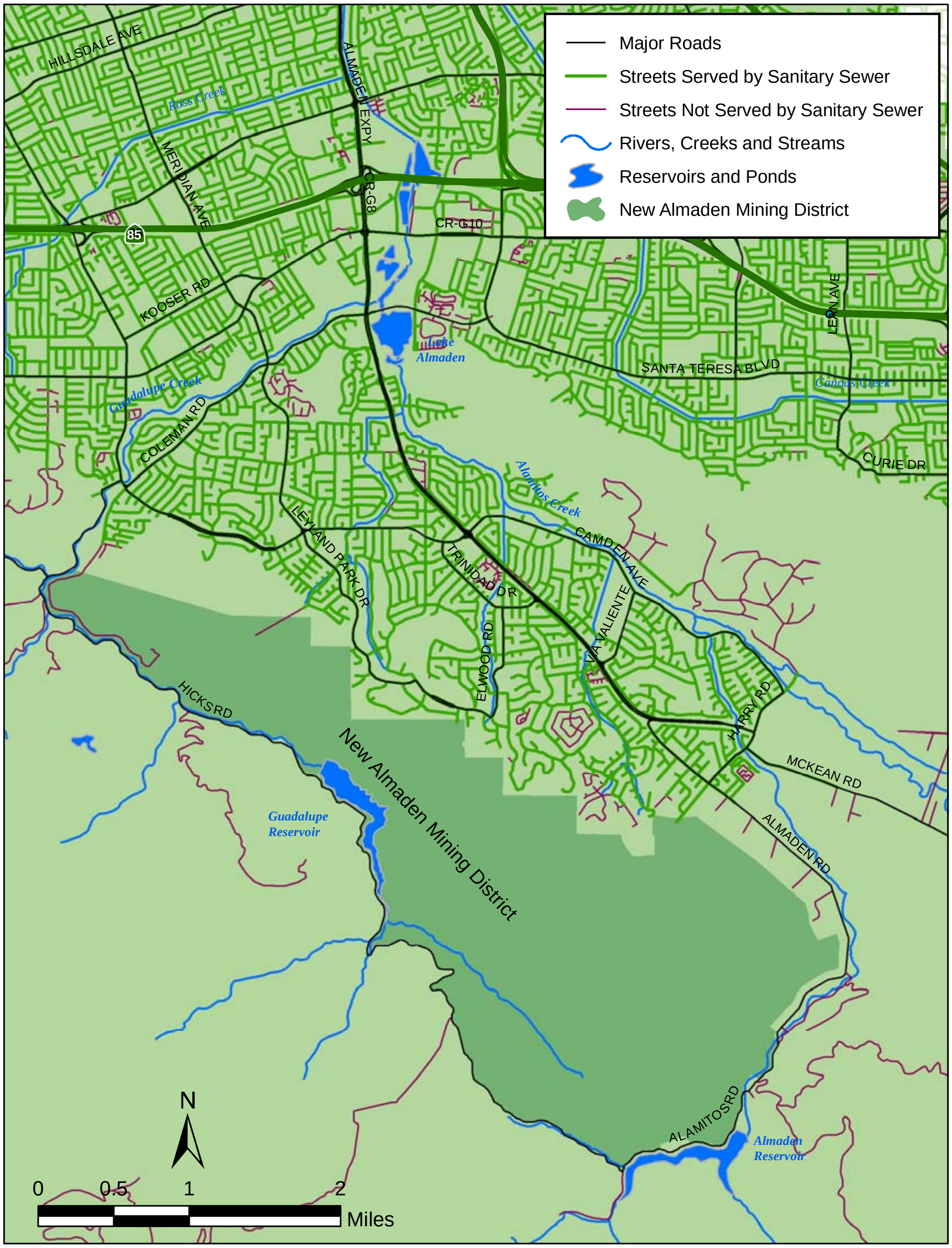



**Figure C.2 Sanitary Sewer Service Area Near Alamitos and Guadalupe Creeks**

*Figure prepared by City of San Jose, 2007*

Note: The actual area served by the sanitary sewer system may be somewhat greater than that depicted due to missing data for small areas of the county and for private streets.

*The End*

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