Water Quality Progress Report

Clear Lake – Mercury

(*Approved 2003*)

WATER QUALITY STATUS

- ○ TMDL targets achieved
- ○ Conditions improving
- ● Improvement needed
- ○ Data inconclusive

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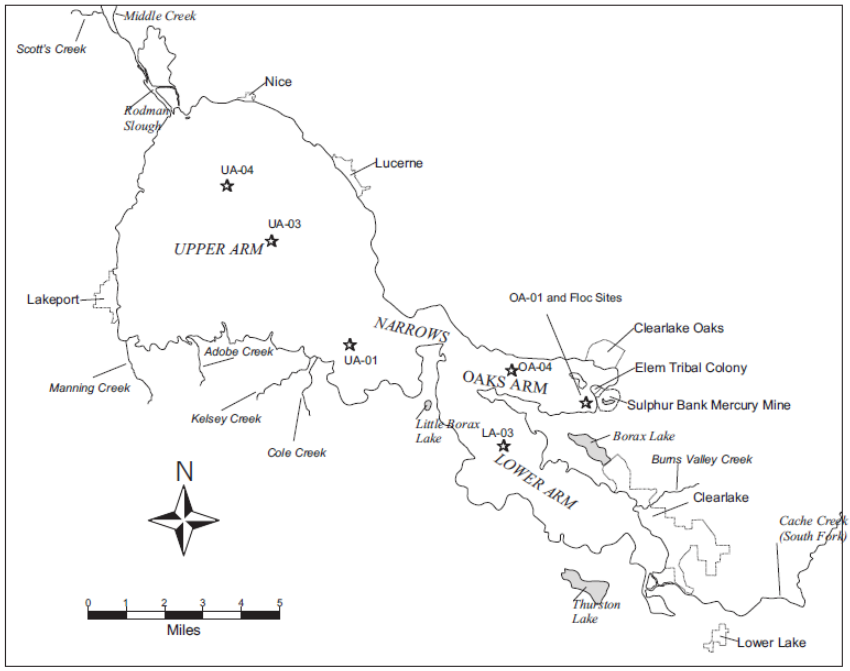
Total Maximum Daily Load (TMDL) Summary

Waterbody – Clear Lake is located in the Coast Range in Lake County, California, about 60 miles northwest of Sacramento. It is a shallow, eutrophic waterbody comprised of three basins: the Upper, Lower and Oak Arms (see map below). A 337,000 acre watershed drains into this 43,000 acre lake. Clear Lake is the largest natural lake located entirely within California's boundaries and is an important local resource.



Overview of Clear Lake

Water Quality Goals

According to the water quality objectives, the **methylmercury** concentration in fish tissue shall not exceed 0.09 and 0.19 mg methylmercury/kg (mg/kg) wet weight of tissue in trophic level[1] 3 and 4 fish, respectively. These objectives were derived to protect wildlife and human health.

These objectives apply to the average of methylmercury concentrations in muscle tissue of trophic level 3 and 4 fish. Representative trophic level 3 fish include carp, hitch, Sacramento blackfish, black bullhead, and bluegill of all sizes; and brown bullhead and catfish less than the trophic level 4 lengths. Trophic level 4 fish are represented by largemouth bass (total length 300-400 millimeters [mm]), catfish (total length 300 – 400 mm), brown bullhead (total length 300-400 mm), and crappie (total length 200-300 mm).

Targeted Attainment Date – Not specified in the TMDL; however, due to the nature of legacy pollutants such as mercury, water quality can take decades to show improvement.

[1] Trophic levels identify the position of an organism in the food chain, ranging from level one to level five where higher values are associated with carnivores and predators.

Water Quality Impairment – Mercury in Clear Lake comes from historic mining activity, natural springs and enriched soils, and deposition from air due to local and global emissions. Mercury is a naturally occurring element that has been mined because it is used for electrical applications, manufacture of chemicals, and certain lighting (among other devices), although its use is decreasing. Mining of mercury occurred in California for both direct use of the mercury as well as to extract gold during California's Gold Rush. It is also released from combustion (burning coal, natural gas, or petroleum). Mercury can be found in numerous chemical forms. One organic form, methylmercury, is the most hazardous form of mercury in the environment and can cause both chronic and acute toxicity to mammals (including humans), birds, and aquatic animals. In humans, methylmercury exposure can cause neurological symptoms as well as developmental concerns for children exposed in-utero. In addition, methylmercury exposure causes reduced reproductive success in wildlife. Within an organism, rates of intake of methylmercury tend to be greater than rates of elimination, such that it accumulates within tissues as an organism ages. Methylmercury also bioaccumulates, becoming increasingly concentrated in higher trophic levels of the food chain. The primary route of exposure for humans and wildlife to methylmercury is through consumption of contaminated fish and other aquatic organisms.

The California Department of Health Services issued a fish consumption advisory for Clear Lake in 1987 and the advisory was most recently updated in May 2014. This advisory recommends limiting consumption of fish from the lake and women ages 18 to 45 and children should not consume largemouth bass. Since the 1970s, samples have been collected by numerous agencies and analyzed for mercury concentrations in tissue (fish and other wildlife), sediment, and water from Clear Lake. These data indicate high concentrations of mercury in all matrices evaluated. Based on elevated levels of mercury in fish tissue and the fish consumption advisory, Clear Lake was added to the California List of Impaired Waterbodies in 1988 because it is not meeting the wildlife habitat and sport/recreational fishing beneficial uses.

Pollutant Sources – The Clear Lake watershed lies within a region naturally enriched in mercury. Anthropogenic and natural activities and sources affect the loading of this mercury into Clear Lake. These activities and sources include past and present discharges from the Sulphur Bank Mercury Mine (SBMM) site, small mercury mines and geothermal sources, natural and anthropogenic erosion of soils with naturally occurring mercury, and atmospheric deposition.

The SBMM site, on the shore of Oaks Arm, was a highly productive source of mercury between 1872 and 1957. Levels of mercury in Clear Lake sediments rose significantly after 1927, when open pit operations became the dominant methodology used at SBMM. Mercury continues to enter Clear Lake from the SBMM site through groundwater, surface erosion, and atmospheric routes. In 1991, the SBMM site was declared a federal Superfund site. Since then, several remediation projects have been completed, including regrading and vegetation of mine waste piles along the shoreline and construction of a diversion system for surface water runoff. At one time, the steep, unvegetated slopes of waste rock piles were a notable source of mercury entering Clear Lake. Remediation of the waste piles appears to have significantly reduced erosion of mine material into the lake.

In addition to SBMM, several smaller mines were located in the Clear Lake watershed, all of which are now inactive. Geothermal springs may also contribute loads as well as runoff from naturally mercury-enriched soils and atmospheric deposition to the watershed. Less significant sources of mercury include atmospheric deposition directly to the surface of Clear Lake and lava tubes that discharge directly to the lake. Another important process in Clear Lake is the conversion of mercury to methylmercury. Methylmercury is produced in surface sediments by bacteria. The chemicals cycle and they also flux between the water column and deposition to the sediment. The methylated mercury is bioavailable to organisms in the food chain, so the active sediment layer is also an important source of mercury to the waters and fish of Clear Lake.

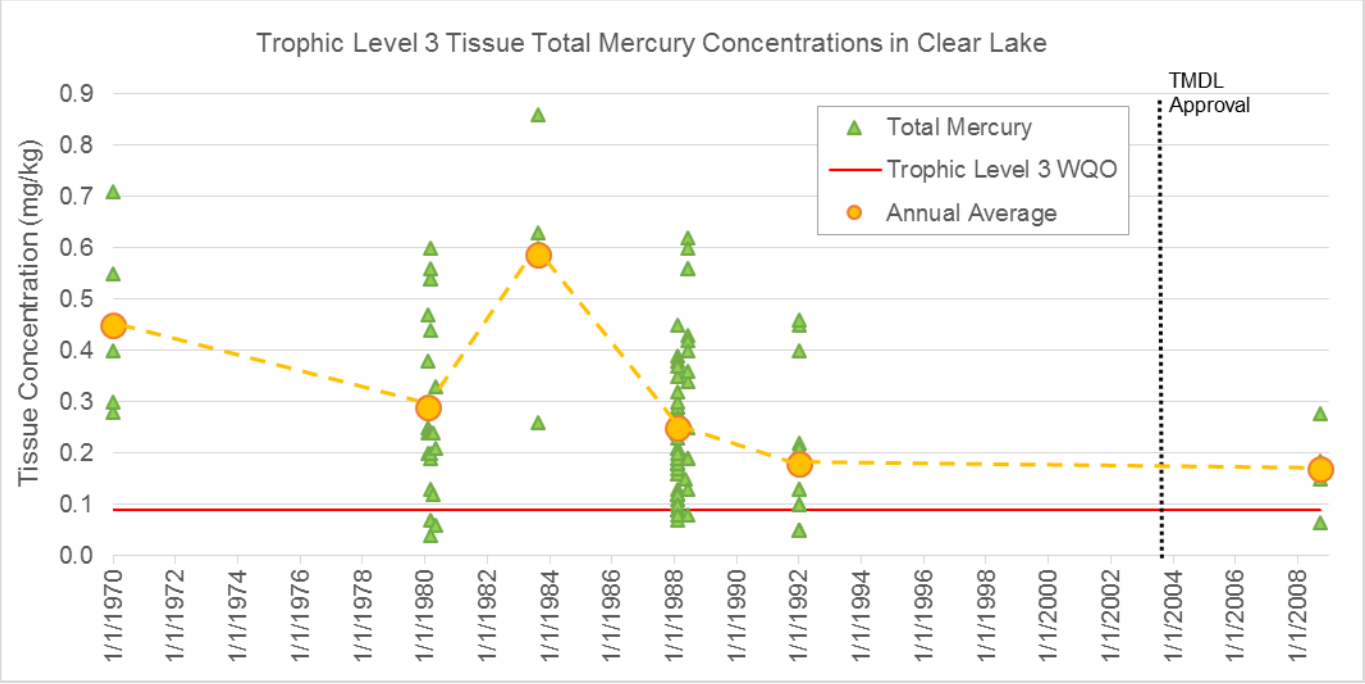
Loading Capacity and Allocations – The loading capacity is the maximum amount of a contaminant or stressor that can be assimilated by the waterbody without exceeding water quality objectives. The mercury loading capacity and source load allocations in this TMDL are equal to reductions in existing sediment and water loads to

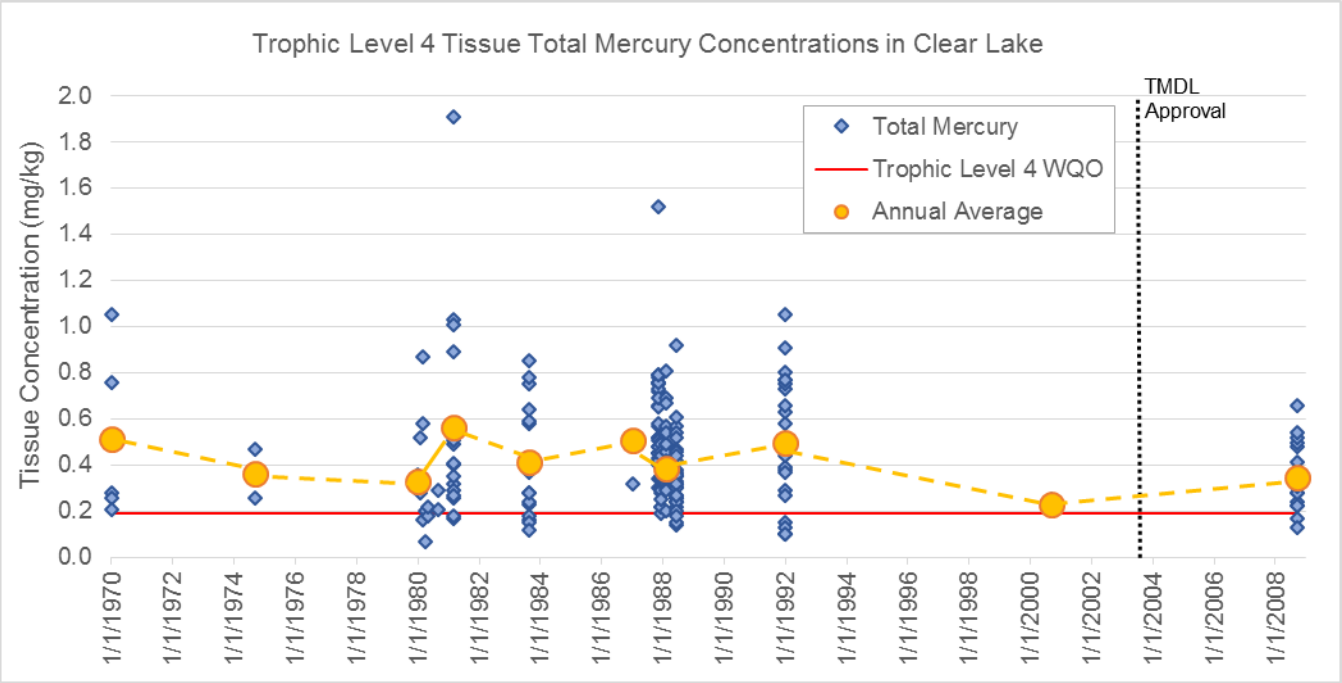
the lake because to reduce levels of methylmercury in fish, loads of mercury to the lake must be reduced. There are no permitted sources that discharge mercury to Clear Lake, the TMDL only identified nonpoint sources.

The TMDL linkage analysis provides a relationship between sediment or water concentrations and fish tissue. The selected water quality objective of mercury in fish tissue protects fish consumers and is the most direct assessment of fishery conditions and improvement. The acceptable daily intake is the quantity at or below which humans consuming mercury are expected to be protected from adverse effects. Levels of methylmercury in fish are assumed to be directly proportional to the concentrations of mercury in surficial sediment. Meeting these fish tissue-based objectives would require a 60 percent reduction from current fish tissue levels. This reduction is equivalent to a 70 percent reduction in concentrations of mercury in surficial sediment from existing levels. These load allocations are divided among the sources. Specifically, Clear Lake sediments receive an allocation of 30 percent of existing concentrations, the SBMM allocation is 5 percent of the existing load from the terrestrial mine site, and tributaries can discharge 80 percent of the existing load while atmospheric deposition remains unchanged. The load allocation for the mine also includes reducing mercury concentrations in surficial sediment to meet sediment compliance goals in Oaks Arm.

Is Water Quality Improving?

Fish tissue data are available for trophic levels 3 and 4 in Clear Lake. Raw data were assigned a trophic level based on the fish species and total length, consistent with the representative fish described above in the water quality objectives section. The data are graphed by date and compared to their applicable water quality objectives to investigate changes in concentration over time. The first graph below shows the trophic level 3 fish tissue concentrations compared to the water quality objective, while the lower graph illustrates the trophic level 4 information. Both graphs show limited data during most of the 1990s and 2000s. When comparing the more recent data collected in 2008 to data from the 1980s, the maximum concentrations have decreased (average annual concentrations represented by circles in the plots below confirm this trend, especially for the tropic level 3 data). However, the majority of samples still have concentrations well above water quality objectives (note: water quality objectives are based on methylmercury, while the data are total mercury values, providing a small margin of safety).





Additional data should be evaluated to fully characterize conditions since TMDL approval. Through continued implementation of management measures associated with the mercury sources, fish tissue concentrations are expected to decrease over time. Due to the nature of legacy pollutants, it can take decades to show improvement in fish tissue concentrations.

TMDL Progress – Implementation activities and milestones

Implementation Activity	Target Date	Status	Progress Details
United States Environmental Protection Agency (USEPA) to submit **remediation plans for the Sulphur Bank** site for Central Valley Water Board concurrence by 2011, and then implement those plans by 2013. USEPA should **complete remediation activities** at the mine site and active lakebed sediment remediation by 2023.	2013 2023	In Progress	• USEPA has performed three removal actions since September 2003, the Elem Pomo Tribe Mine Waste Removal Action (link), the Sulphur Bank Road Mine Waste Removal Action (link), and the Bureau of Indian Affairs (BIA) Road 120 Waste Removal Action. • Feasibility studies ongoing for Operable Units 1 and 2 (link). • USEPA, the Central Valley Water Board, and the Department of Toxic Substances Control (DTSC) continue to discuss remediation options for Operable Unit 1. USEPA is considering an addendum to the 2006 Record of Decision based on additional ideas from DTSC.
USEPA to continue necessary **remediation activities on the Sulphur Bank mine site** and prepare an implementation plan or plan(s).	None specified	In Progress	• Construction of Test Covers in Clear Lake (link) • USEPA has two ongoing Feasibility Studies, Operable Unit 1 (The Mine Property), and

Implementation Activity	Target Date	Status	Progress Details
			Operable Unit 2 (Clear Lake Sediment and North Wetland). • Final Community Involvement Plan for Operable Unit 1 (link)
The United States Bureau of Land Management (USBLM), United States Forest Service (USFS), other land management agencies in the Clear Lake Basin, and Lake County shall submit **plans for monitoring and implementation of mercury load reduction projects** by 2008.	2008	Complete	• Monitoring and Implementation Plan was developed by Lake County, in coordination and collaboration with land management agencies and other Clear Lake Watershed stakeholders (link). • As co-permittees in the Municipal Stormwater Program, the County and Cities have collaborated and coordinated in the development of a Stormwater Management Plan (link).
Central Valley Water Board staff will **coordinate the development of monitoring activities to investigate other sources of mercury loads** to Clear Lake.	None specified	Complete/ Ongoing	• Caltrans monitoring stations along the northern portion of Clear Lake. • Final report for the 2003 Proposition 13 grant was submitted by Lake County and approved by Central Valley Water Board (link).
Central Valley Water Board staff will **work with the Native American Tribes** in the Clear Lake watershed on **mercury reduction programs** for the tributaries and surface water runoff.	None specified	Complete/ Ongoing	• Six federally recognized Tribes have been active in the notification of Clear Lake Mercury TMDL activities, plans and projects. Central Valley Water Regional staff continues to coordinate with each Tribe to ensure information transfer, participation, and that Clear Lake Mercury TMDL actions are inclusive. Central Valley Water Board staff continues outreach to non-federally recognized Tribes that may be interested in TMDL implementation in the Clear Lake Watershed. • Tribes are conducting remediation and water quality/sediment monitoring, as well as stream and habitat restoration and sediment control projects.
Central Valley Water Board staff, USBLM, USFS and other land management agencies in the Clear Lake Basin, and Lake County will **assess the potential for production of methylmercury** during the planning of any **wetlands or floodplain restoration** projects within the Clear Lake watershed.	None specified	Complete/ Ongoing	• Coordination with the Army Corps of Engineers and Lake County for the Middle Creek Ecosystem Restoration and Flood Damage Reduction Project (link) and Highlander Ranch Reservoir Project. • Also coordinates with all Clear Lake stakeholders regarding best management practices that incorporate the use of wetlands, among others.

Implementation Activity	Target Date	Status	Progress Details
The Lake County Public Health Department will provide **outreach and education** to the community, emphasizing portions of the population that are at risk, such as pregnant women and children.	None specified	Complete/ Ongoing	• Updated website with information on mercury in fish with links to several guides (link)
Additional **sediment reduction best management practices**.	None specified	Complete/ Ongoing	• USBLM and USFS are conducting numerous sediment control projects, including Off-Highway Vehicle programs, trail maintenance, revegetation plans, fuel reduction programs to manage forest fires, grazing controls, site characterizations, and erosion control along roads.
The Central Valley Water Board will **review the progress toward meeting the fish tissue objectives** for Clear Lake every five years. This review is to coincide with the five year review to be conducted by USEPA for the Record of Decision for the Sulphur Bank Superfund Site.	Every 5 years	In Progress	• Clear Lake Mercury TMDL Update, November 2010 (link)
TMDL Compliance Monitoring			
Fish tissue sampling for trophic level 3	Every 10 years	In Progress	• Data are collected by California Department of Fish and Game (CDFG), University of California at Davis (UCD), California Department of Health Services (DHS), among other agencies. • Data are reported and available through CEDEN (www.ceden.org).
Fish tissue sampling for trophic level 4	Every 10 years		
Indicator species sampling (silversides and largemouth bass less than one year old)	Every 5 years		
Total mercury in tributary sediment, lake sediment, and water	Every 5 years	In Progress	• Final Report Clear Lake Watershed TMDL Monitoring Program, Proposition 13 Watershed Protection Grant Program, Lake County Watershed Protection District (link)

What Next?

Additional reductions are needed to achieve water quality goals. Remediation at the Sulphur Bank Mercury Mine site will be the most effective driver for water quality improvement in the lake. DTSC and USEPA are reviewing information in preparation to amend the Record of Decision which will guide clean up actions.

Information Source Documents

- **Staff Report (Total Maximum Daily Load Report) and Functionally Equivalent Document** for the Control of Mercury in Clear Lake (link)

- **Central Valley RWQCB TMDL Resolution** – Amending the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Mercury in Clear Lake, Resolution No. R5-2002-0207 (link)
- **Central Valley RWQCB TMDL Resolution Approval** – Approving an Amendment to the Water Quality Control Plan for the Central Valley Region to Establish a Program for the Control of Mercury in Clear Lake (link)
- **Clear Lake TMDL for Mercury Numeric Target Report**, Staff Report, June 2001 (link)
- **Clear Lake Mercury TMDL Update**, November 2010 (link)
- **General Permit for the Discharge of Storm Water from Small Municipal Separate Storm Sewer Systems** (link)
- **Lake County Clean Water Program** (link)
- **Annual Reports for Lake County Clean Water Program** (link)
- **Clear Lake Watershed TMDL Monitoring Program**, Proposition 13 Watershed Protection Grant Program, Lake County Watershed Protection District, April 14, 2009 (link)
- **Clear Lake Integrated Watershed Management Plan** and Watershed Assessments (link)
- **Sulphur Bank Mercury Mine Superfund Information** (link)