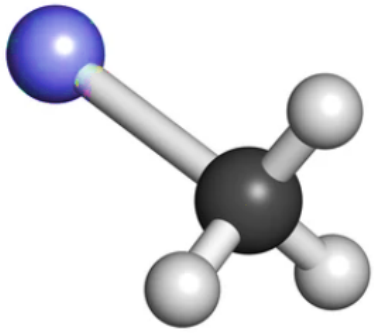
Groundwater Fact Sheet
Mercury (Hg)



Constituent of Concern
Mercury

Synonym
Quicksilver, Liquid Silver, and Hydrargyrum

Chemical Formula
Hg

CAS Number
7439-97-6

Storet Number
71900

Summary
The current State and Federal Maximum Contaminant Levels (MCL) for inorganic mercury is 2 micrograms per liter (µg/L). Mercury occurs as a native metal or is bound to other elements in minerals. In these forms, it is referred to as "inorganic mercury" and its most common sources include discharges from metal processing, incineration of coal, medical and other waste, and mining of gold and mercury ores. Inorganic mercury may combine with one carbon and three hydrogen atoms (CH_3). And be referred to as "organic or methyl mercury". Despite its toxicity, no MCL is set for the organic form. In 2000, the U.S. Environmental Protection Agency (EPA) promulgated the California Toxics Rule (CTR) for inland surface waters. This rule establishes criteria for consumption for both inorganic and organic mercury.

Based on State Water Resources Control Board (SWRCB) data from 2007 to 2017, 16 active and standby public water wells (of 9,201 well tested, 1,104 detections) had at least one detection of mercury above the MCL. Mercury levels above the MCL in public groundwater sources were primarily found in Kern (4 wells), Los Angeles (3 wells), and Napa (2 wells) counties, with a maximum concentration of 94.4 µg/L in Monterey County.

REGULATORY WATER QUALITY LEVELS[1]
MERCURY (Hg)

Type	Agency	Concentration
Federal MCL	EPA[2]	2 µg/L
State MCL	SWRCB[3]	0.2 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB[3]	1 µg/L
Public Health Goal (PHG)	OEHHA[4]	1.2 µg/L
CTR Human Health Criteria for Consumption of Water and Organisms	EPA[2]	0.050 µg/L
Reference dose for methyl mercury RfD[5]	EPA[2]	0.1 µg/kg/day

[1]Other water quality levels may exist. For further information, see "A Compilation of Water Quality Goals", 17th Edition (SWRCB).
[2]EPA – United States Environmental Protection Agency
[3]SWRCB - State Water Resources Control Board
[4]OEHHA – Office of Environmental Health Hazard Assessment
[5]RfD - Assumes 70 kg body weight, 2 liters/day drinking water consumption and 20% relative contribution from drinking water.

MERCURY DETECTIONS IN PUBLIC WATER WELL SOURCES[6]	
Number of active and standby public water wells with mercury concentrations > 2 µg/L [7]	16 of 9,201 wells tested with 1,104 detections
Top 3 counties with mercury detection in public wells above the MCL	Kern (4), Los Angeles (3), Napa (2)

[6]Based on 2007-2017 public standby and active well (groundwater sources) data collected by the SWRCB.
[7]Water from active and standby wells is treated to prevent exposure to chemical concentrations above the MCL or other health-based benchmarks. Data from private domestic wells and wells with less than 15 service connections are not available.

ANALYTICAL INFORMATION			
Approved EPA methods	200.7	200.8	1631
Detection Limit (µg/L)	0.2	0.2	0.002
Notes	Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Cold Vapor Atomic Absorption (CVAA)
Known Limitations to Analytical Methods	Proper sample handling is required for samples tested by EPA Method 1631, where even minor contamination may greatly affect the results.		
Public Drinking Water Testing Requirements	Mercury is a regulated chemical for drinking water sources, with monitoring and compliance requirements (Title 22, Section 64431, et seq.).		

Mercury Occurrence

Anthropogenic Sources

Globally, approximately 5,000 tons of mercury are released to the environment per year due to anthropogenic activities. The United States contributes approximately 3 percent of the world's total mercury emissions, with coal combustion responsible for about one-third of the total US contribution (approximately 48 tons per year). Production of electronic products such as dry-cell batteries, fluorescent light bulbs, thermostats, and other equipment account for the remaining industrial contribution of mercury to the environment. Improper handling or disposal of these items results in the release of mercury to the environment.

In the past, mercury was used in fungicides and wood preservatives. Trace amounts of mercury may still be found in some wood preservatives and paints. Other sources include smelters and catalyst manufacturing. In the United States the amount of mercury released to the environment from industrial sources has been rapidly declining and is now less than half the amount released during the 1950s.

Other anthropogenic sources of mercury to the environment include wastes and byproducts from dentistry and historic mining. Dental fillings (amalgam) consisting of approximately 50% mercury are

widely used throughout the United States. An estimated 35 tons per year of mercury are released to the environment through use of amalgam fillings. In California, historic mercury mining in the Coast Ranges and mercury used for gold ore recovery in the Sierra Nevada are also a continuing source of mercury.

Natural Sources

Mercury is naturally present in geological formations, soil, water, air, plants, and animals. Elemental mercury can readily volatilize and enter the atmosphere, where it will react with other elements and precipitate. Natural sources of mercury include volcanoes, geologic deposits of mercury, volatilization from the ocean, and some geothermal springs.

Approximately half of all mercury released to the environment is natural in origin.

History of Occurrence

Approximately 90% of all mercury used in the United States between 1846 and 1890 (about 115,000 tons) was mined from the California Coast Ranges. Over 11,000 tons of mercury was used in Sierra Nevadan gold mines – because mercury combines with small gold flakes, mercury used in sluices allowed greater gold recovery. Approximately 39,000 tons of mercury were released to the environment from mines in the Coast Ranges. Approximately 6,500 tons of mercury entered the environment as the result of mining activity in the Sierra Nevada. Mercury from historical mining continues to enter the environment through stream runoff.

Contaminant Transport Characteristics

Mercury naturally volatilizes from soil and surface waters and enters the atmosphere. Ambient air concentrations of mercury have been reported to average between 10 to 20 nanograms per cubic meter (ng/m^3). Mercury from the atmosphere is the dominant source to most of the land surface. Most atmospherically deposited mercury will re-volatilize or be adsorbed by organic material in the soil. As a result, only a very small amount of mercury is transported to groundwater. Mercury can also occur naturally in groundwater, usually at low concentrations. In some cases, elevated mercury in groundwater may result from releases from past mining and chemical spills, or from improper disposal of materials that contain mercury. Groundwater generally contains less than 2 µg/L of mercury, although areas near historic mining districts or where certain geologic conditions are prevalent may have locally higher concentrations.

Freshwaters without known sources of mercury contamination generally contain less than 5 ng/L of total mercury in aerobic surface waters. However, surface water contamination is significantly more extensive than groundwater contamination. Inorganic mercury may be converted to methyl mercury, which is soluble, mobile, and quickly enters the aquatic food chain. Methyl mercury accumulates in biological tissue more quickly than inorganic mercury. Concentrations in carnivorous fish tissue at the top of the food chain ("top trophic") may have methyl mercury concentrations from 10,000 to 100,000 times greater than that of the surrounding water. *Bioaccumulation* occurs in organisms when the rate of intake exceeds the rate at which the contaminant is removed from the organism; the bioaccumulation rate of methyl mercury exceeds inorganic mercury. As a result, most of the mercury found in top trophic fish tissue is in the form of methyl mercury. Since methyl mercury is not typically found in groundwater, DDW does not typically require sampling except in rare instances.

Remediation and Treatment Technologies

The main types of treatment processes accepted by the EPA for mercury in water are:

- Precipitation — coagulation/filtration (C/F)
- Lime softening (LS)
- Adsorption processes — Granular Activated Carbon (GAC)
- Membrane filtration — reverse osmosis (RO)

In-situ methods include chemical precipitation (immobilization) and impermeable barriers.

Health Effect Information

According to EPA 1996 IRIS database information, mercury is not classifiable as a human carcinogen. There is inadequate evidence in humans for the carcinogenicity of mercury and mercury compounds.

The kidney appears to be the critical organ of toxicity for the ingestion of mercuric salts. Acute renal failure has been observed in a number of case studies of mercuric chloride ingestion. The other major target organ for metallic and organic mercury is the nervous system. A range of neurological changes are produced by inhalation or ingestion of both high and low levels of food, fish and marine mammals contaminated with methyl mercury.

Key Resources

1. Agency for Toxic Substances and Disease Registry (ATSDR). 2013. ToxProfiles. http://www.atsdr.cdc.gov/toxprofiles/mercury_organic_addendum.pdf
2. California State Water Resources Control Board, A Compilation of Water Quality Goals, 17th Edition, (SWRCB, 2016). http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf
3. California State Water Resources Control Board, 2016, Chemicals and Contaminants in Drinking Water. http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Chemicalcontaminants.shtml
4. Carnegie Mellon University, Remediation of Metals-Contaminated Soils and Groundwater, TE-97-01. http://www.clu-in.org/download/toolkit/metals.pdf
5. Central Valley Regional Water Quality Control Board, Delta Methylmercury TMDL – June 2006 Draft Staff Reports https://www.epa.gov/sites/default/files/2015-03/documents/ca5-methylmercury.pdf
6. Department of Toxic Substances Control (DTSC). 2007. Mercury Waste. https://dtsc.ca.gov/toxics-in-products/mercury-waste/#whatis
7. Northeast Waste Management Official's Association (NEWMOA). https://p2infohouse.org/ref/47/46753.pdf
8. Storm, D.L. 1994. Chemical monitoring of California's public drinking water sources: Public exposures and health impacts. In: Wang, R.G.M. Water Contamination and Health. New York, Marcel Dekker, Inc. 67-124.
9. United States Department of Energy. 2006. Mercury Control R&D. http://energy.gov/fe/articles/milestone-project-demonstrates-innovative-mercury-emissions
10. United States Environmental Protection Agency (EPA). Basic Information about Mercury (inorganic) in Drinking Water https://www.epa.gov/mercury/basic-information-about-mercury#overview
11. United States Geological Survey. 2008. California Water Science Center. https://www.usgs.gov/centers/california-water-science-center/science/mercury
12. US Geological Survey. 2000. Mercury in the Environment, Fact Sheet 146-00. https://www2.usgs.gov/themes/factsheet/146-00/#toxic

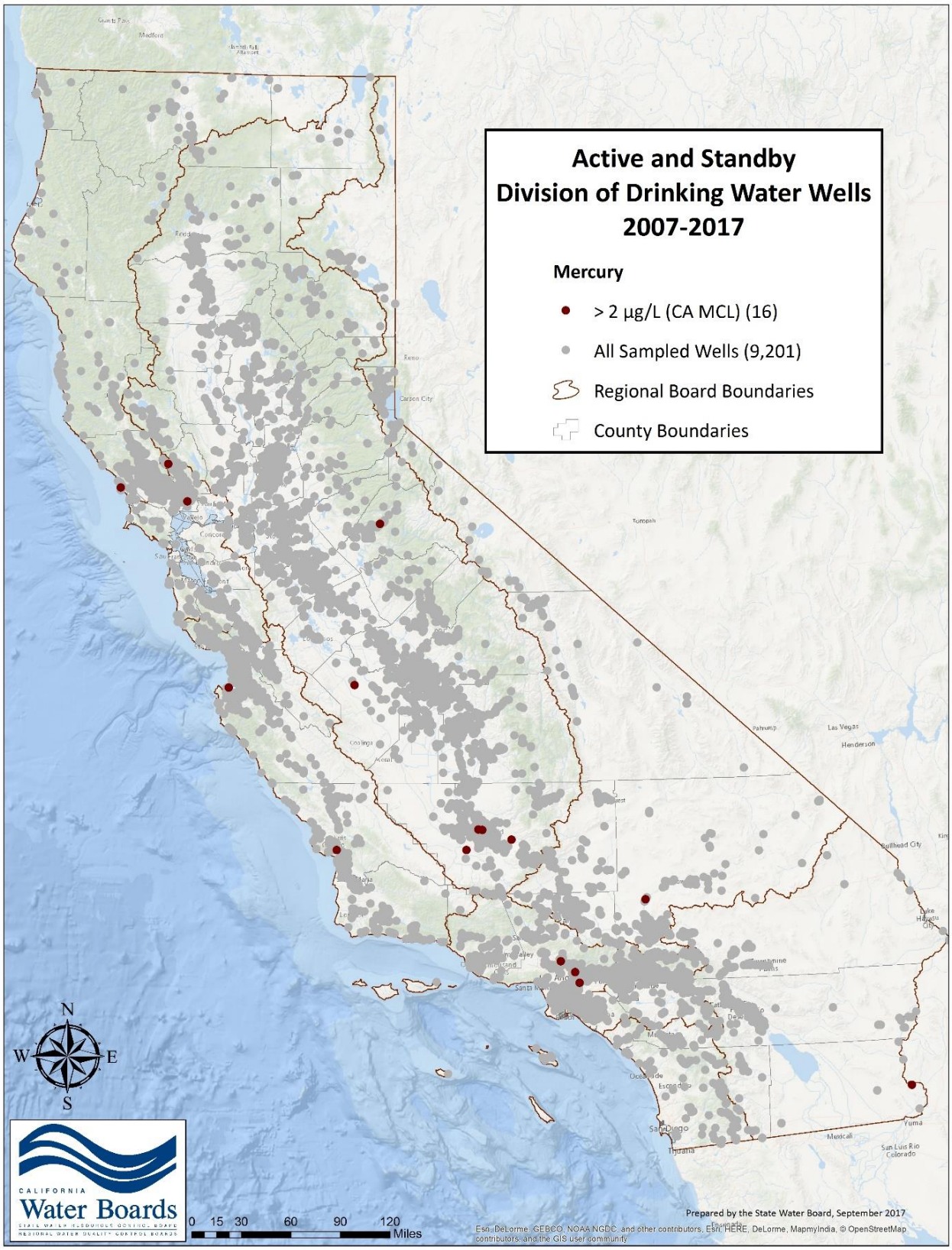


Figure 1. Active and standby public drinking water wells that had at least one detection of mercury above the MCL, 2007-2017, 16 wells. (*Source: Public supply well data in GAMA GIS*).