April 23, 2013

Reducing Mercury Contamination in Sediments Improves Three Walker Creek Watersheds (California)

REPORTING WATERSHED IMPROVEMENT
Based on Statistical Evidence of Watershed-wide Improvement (Option 2a)

Executive Summary

Three Walker Creek watersheds show watershed-wide improvement in reducing mercury contamination in sediments. Mercury reductions were achieved using a watershed approach that included both regulatory and non-regulatory mechanisms. These mechanisms were targeted to the three primary sources of mercury and sediment in the watershed: Gambonini Mine, Soulajule Reservoir, and grazing operations. The Gambonini Mine site cleanup has resulted in a 92-93% mercury load reduction from the mine and significant reduction in mercury/methlymercury concentrations. Restoration will continue through the implementation of the Grazing Waiver, a regulatory tool for controlling nonpoint source pollution, and associated management practices.

Watershed Identification

a	Organization	San Francisco Bay Regional Water Quality Control Board
b	Point of Contact	James D. Ponton, Senior Engineering Geologist San Francisco Bay Regional Water Quality Control Board 1515 Clay Street, Suite 1400, Oakland, CA 94612 Phone: (510) 622-2492 Email: jponton@waterboards.ca.gov
c	Project Title	Reducing Mercury Contamination in Sediments Improves Three Walker Creek Watersheds, Marin County, California
d	No.Watersheds Improved	Three improved watersheds, Arroyo Sausal 180500050201, Chileno Creek 180500050202, and Walker Creek 180500050203. (Figures 1). Available data show statistically significant water quality improvements due to a reduction in mercury discharges in the Walker Creek watershed.

Description of 2002 Baseline Condition [1,2]

e	Watershed(s)	Walker Creek Watershed is comprised of three HUC 12 sub-watersheds (Figure 1 and Figure 3): 180500050201 – Arroyo Sausal Creek 180500050202 – Chileno Creek 180500050203 – Walker Creek
f	2002 Impairments	In 1993, the lower 16 miles of Walker Creek were added to the federal Clean Water Act Section 303(d) list of impaired waters as having water quality impaired for mercury, nutrients, and sediment. The impairment listing determined that mercury, nutrients, and sediment were impairing the habitats

		beneficial to coho salmon, including migration, spawning, and rearing and identified surface mining, mine tailings, and agriculture as the probable causes.
g	Map (optional)	Figures 1, 2, and 3: Maps of Walker Creek Watersheds including HUC Codes and Walker Creek sampling (sediment, water, and fish tissue) locations. Additional maps are available in these online documents: • Walker Creek Mercury TMDL Staff Report • Tomales Bay Watershed Pathogens TMDL Staff Report

Evidence of Watershed Approach [1,2]

h	Area of Effort	Walker Creek Watershed, Marin County, California The Walker Creek watershed is comprised of roughly 197 square kilometers (76 sq. miles) of low rolling hills and steep canyons. It drains into the northern end of Tomales Bay, western Marin County. Walker Creek is the second largest tributary to Tomales Bay. The Walker Creek watershed receives between 24–32 inches of precipitation annually, supplying roughly 25 percent of the annual runoff received by Tomales Bay. The Walker Creek watershed is comprised predominantly of grassland (61 percent) with about 24 percent of the watershed forested by riparian hardwood. The susceptibility of the underlying geology of the watershed to failure and fracture leads to a low to moderate erosion potential of soils factoring in slope, and precipitation. Ninety-six percent of the watershed is in private ownership and the major land use is dairy rangeland. The remaining 4 percent is state and locally owned lands. A small number (approximately 300) of residential homes are located primarily along the east shore of Tomales Bay. Besides tourism, oyster farming is a major industry in Tomales Bay with a shellfish area adjacent to the Walker Creek Delta (the terminus of Walker Creek).
i	Key Stake-holders Involved and Their Roles	San Francisco Bay Regional Water Quality Control Board The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) is the State of California regional water quality agency responsible for implementing the federal Clean Water Act as well as state water quality laws and regulations in the San Francisco Bay Region. The Walker Creek watershed is located within the northern portion of our region. The Regional Water Board's key roles in the Walker Creek Watershed include: • Issuing a Cleanup and Abatement Order in 1993 for cleanup of the Gambonini mercury mine site (Figure 1); • Securing funding from the State's Cleanup and Abatement Account and managing funding to implement non-operational cleanup measures at the Gambonini mine site such as erosion control, channel restoration, and site vegetation; • Conducting stakeholder outreach throughout the development and

implementation of the Walker Creek Mercury and Tomales Bay Pathogen TMDLs;
- Developing and implementing the 2007 Tomales Bay Pathogens TMDL (Walker Creek serves a tributary to Tomales Bay);
- Developing and implementing the 2008 Walker Creek Mercury TMDL;
- Developing and implementing a conditional waiver of Waste Discharge Requirements for Grazing Operations (2008) in the Tomales Bay watershed (Grazing Waiver) as a component of the State's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program to help minimize and control pathogen and sediment delivery (including disturbances to mercury-laden creekside sediments) to the Watershed and Tomales Bay;
- Providing stakeholder assistance and outreach during the development and implementation of the Grazing Waiver;
- Managing federal Clean Water Act 319(h) grants, Proposition 50 (Water Security, Clean Drinking Water, and Coastal and Beach Protection Act of 2002) grants for watershed restoration projects;
- Assisting local stakeholders with Grazing Waiver implementation, and the Gambonini mine site cleanup; and,
- Inspecting sites, responding to complaints, and undertaking enforcement, as necessary.

State Water Resources Control Board

The State Water Resources Control Board (State Water Board) protects water quality by setting statewide policy, coordinating and supporting the Regional Water Board efforts, and reviewing petitions that contest Regional Water Board actions.

The State Water Board's role in the Walker Creek Watershed has involved:
- Approving the Tomales Bay Pathogens and Walker Creek Mercury TMDLs;
- Providing financial assistance to stakeholders in the Walker Creek watershed through the issuance of federal Clean Water Act 319(h) grants, Proposition 50 grants, and Cleanup and Abatement Account funds (an estimated $971,300 in CAA funding was used for the remediation and stabilization of the Gambonini mine site);
- Funding the Regional Water Board's Regional Monitoring and Assessment Strategy (RMAS) which was used to develop information for all waterbodies in the Region for the federal Clean Water Act Integrated 305(b)/303(d) Report.

  The Surface Water Ambient Monitoring Program (SWAMP) was used to implement the RMAS. The Walker Creek watershed was one of the planning watersheds monitored by SWAMP in 2001-2003. The monitoring consisted of measuring water quality parameters, bio-assessment, and collecting sediment and fish tissue samples for mercury analysis. This information was in turn used to develop the Walker Creek Mercury TMDL.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (U.S. EPA) played a critical role in the efforts undertaken in the late 1990's to abate the erosion and transport of mercury wastes from the Gambonini mercury mine downstream through Walker Creek and out into Tomales Bay.

U.S. EPA efforts included:

- Initiating an emergency Superfund (CERCLA) cleanup action in August 1999 to eliminate the discharge of mercury-laden sediments from the Gambonini mine site;
- Providing the lead agency role in mine site cleanup;
- Conducting all earth moving and engineering work at the Gambonini mine including extensive slope stabilization, re-contouring/benching, and re-vegetation of the site;
- Expending approximately $2,700,000 in Superfund funds on the cleanup of the Gambonini mine;
- Providing federal Clean Water Action 319 funding for TMDL implementation in the watershed through regulatory compliance activities and implementation projects; and
- Approving the Tomales Bay Pathogens and Walker Creek Mercury TMDLs.

Office of Environmental Health Hazard Assessment

The Office of Environmental Health Hazard Assessment (OEHHA) is responsible for developing and providing risk managers in state and local government agencies with toxicological and medical information relevant to decisions involving public health.

OEHHA's role included:

- Issuing an interim public health advisory in December 2000 based on 1999 fish and shellfish sampling data that showed that some fish species in caught in Tomales Bay contained high levels of mercury and could pose health risks to people who eat them.
- Conducting additional, follow-on study of fish and shellfish to confirm that some types of fish have high levels of mercury; and,
- Evaluating the results of these later studies and issuing revised health advisory guidelines for limiting consumption of fish and shellfish from Tomales Bay.

Tomales Bay Grazing Land Partnership

The Tomales Bay Grazing Land Partnership (Partnership) consists of representatives from the Marin County Resource Conservation District, Marin Farm Bureau, Marin Agricultural Land Trust, California Cattleman's Association, Western United Dairymen, University of California Cooperative Extension, Point Reyes National Seashore, and U.S. Department of Agriculture (USDA) Natural Resource Conservation Service.

The Partnership's role in the Walker Creek watershed has involved:

- Assisting landowners with implementation of grazing management practices that control and minimize mercury, pathogen, sediment, and nutrient discharges; and,
- Serving as a liaison between the Regional Water Board staff and ranchers in the Watershed to help disseminate information and clear up any misinformation about the requirements of the Grazing Waiver and how the Grazing Program is administered.

Marin County Resource Conservation District

The Marin County Resource Conservation District (RCD) assists landowners in making the most efficient use of their farms and ranches. The RCD believes in a grassroots approach and that conservation accomplishments are best made through education and cooperative actions.

The RCD's role in the Walker Creek Watershed has included:

- Coordinating with other Marin County agricultural resource agencies to implement a program to improve water quality on grazing lands in the Tomales Bay Watershed (including Walker Creek watershed);
- Implementing TMDLs through workshops, on-farm planning, site visits, and monitoring of management practices on grazing and dairy lands through $1.425 million in combined Proposition 13 and federal Clean Water Act 319(h) grant funding; and,
- Assisting landowners within the Walker Creek watershed with implementation of grazing management practices designed to address mercury, sediment, pathogen, and nutrient discharges. This project was funded through two contracts totaling $230,000 from the CAA.

Point Reyes National Seashore

The Point Reyes National Seashore, as part of a federal Clean Water Act 319(h), conducted surveys of all rangelands to document water quality pollution sources. As a result of these surveys, the park:

- Prioritized and completed implementation and monitoring of best management practices (BMPs) at thirteen treatment locations to address animal concentration and watering areas adjacent to streams and wetlands during the rainy season and to reduce pathogen loading into stormwater delivered to Tomales Bay.

Tomales Bay Watershed Council

The Tomales Bay Watershed Council (Council) was formed in 1999 with the charge of addressing environmental problems affecting Tomales Bay on a watershed scale. The Council is a broad-based group of local residents, public agencies and conservation organizations with a mission of protecting and restoring the health and vitality of the Bay.

Working together with local stakeholders, the Council has:

- Developed a Watershed Stewardship Plan in 2003 with the goals of:

	a) Ensuring water quality is sufficient to support natural resources and beneficial uses b) Restoring the integrity of natural habitats c) Developing strategies to implement the Plan, and d) Educating the public on watershed issues. ▪ Implemented a comprehensive long-term monitoring program to document baseline conditions and to identify trends for pollutants of concern; ▪ Supported implementation of practices and projects that reduce nonpoint sources of water pollution; and ▪ Received two significant Proposition 50 grants in 2006 and 2007. The first funded the development of an *Integrated Coastal Management Plan, Septic Solutions Report, and* Municipal Stormwater Assessment and Recommendation Report. The second grant funded the implementation of the Tomales Bay Wetlands Restoration and Monitoring Program, the Giacomini Wetland restoration project, and water quality monitoring (restoration monitoring, source area monitoring, and long term trends monitoring).
Watershed Plans	A. The Walker Creek Mercury TMDL and Implementation Plan became effective on September 29, 2008. Sources that have the potential to discharge mercury to surface waters in the Walker Creek watershed that were identified in the TMDL include: • Gambonini Mine site; • Soulajule Reservoir watershed and adjacent sub-watersheds; • Downstream mercury-laden depositional areas (creek beds, banks, and floodplains) within Walker Creek; and, • Background sources (weathering and erosion of naturally occurring, mercury-rich hard rock and soil) and atmospheric deposition. The Walker Creek Mercury TMDL assigns a wasteload allocation of 5 mg mercury/kg suspended sediment to stormwater originating from the Gambonini mine site. Soulajule Reservoir and its watershed, Walker Creek's mercury-rich depositional areas, and background sources are each assigned load allocations as follows: • 0.04 dissolved methylmercury per liter and 0.5 mg mercury per kg suspended sediment for the Soulajule watershed and reservoir; • 0.5 mg mercury per kg suspended sediment for downstream depositional areas; and, • 0.2 mg mercury per kg suspended sediment for background sources. The implementation plan builds upon previous and ongoing efforts to reduce mercury loads in Walker Creek and its tributaries and requires: • The owner/operator of the Gambonini mine site to apply for coverage under the Industrial Storm Water General Permit Order 97-03-DWQ (General Industrial Permit) and prepares and implements a Stormwater Pollution Prevention Plan for the site. • The Marin Municipal Water District prepare a monitoring and implementation plan and schedule to 1) characterize fish tissue, water, and suspended sediment mercury concentrations in Soulajule Reservoir and Arroyo Sausal Creek, and 2) develop and implement

methylmercury production controls necessary to attain both in-reservoir and downstream TMDL targets.

- Projects or activities regulated under waste discharge requirements or waiver of waste discharge requirements that are located creekside and downstream of the Gambonini mine and Soulajule Reservoir must evaluate and incorporate management practices that minimize mercury discharges and methylmercury production.
- Projects regulated under Clean Water Act Section 401 located downstream of Gambonini mine and Soulajule Reservoir include provisions to minimize mercury discharges and methlymercury production.
- The County of Marin to update their *Permit Guidance for Unincorporated Areas of Marin* to include specific guidance for projects in areas that may contain mercury-enriched sediments.

B. The Tomales Bay Pathogens TMDL became effective on February 8, 2007. The TMDL identified several source categories for pathogens to surface waters including onsite waste water treatment systems (OWTS), small wastewater treatment facilities and sewage holding ponds, boat discharges, grazing lands, dairies, equestrian facilities, and municipal runoff. The TMDL addresses pathogen impaired waterbodies in Tomales Bay, Lagunitas Creek, Walker Creek, and Olema Creek

The Tomales Bay Pathogens TMDL consists of density-based coliform bacteria TMDL targets that ensure protection of water contact recreational uses and Bay shellfish harvesting, thereby minimizing human exposure to disease causing pathogens.

The implementation plan to reduce pathogen loads to Tomales Bay and its tributaries requires:

- The Marin County Community Development Agency to submit a plan and schedule to evaluate OWTS performance, to bring identified OWTS up to adequate performance standards, and to report annually to the Regional Water Board on progress made in the Watershed;
- Small wastewater treatment facilities to comply with applicable waste discharge requirements;
- Boat facilities to determine the adequacy of onshore restroom facilities and boater disposal/pump out facilities, and to prepare a schedule for a determination of Pump-out Facility Need and Public Hearing Notification, as appropriate;
- Participating agencies (Point Reyes National Seashore, California Coastal Commission, California State Lands Commission, California State Parks, County of Marin, Gulf of the Farallones National Marin Sanctuary, and Regional Water Board) to develop and implement a Tomales Bay boating management plan that includes evaluation of existing moorings and water quality impacts, and permitting and enforcement procedures, to ensure compliance with applicable mooring requirements;
- Operators/owners of grazing lands, dairies, and equestrian facilities to comply with the requirements of applicable waste discharge requirements or waivers of waste discharge requirements designed to reduce animal waste runoff; and,

- Marin County Stormwater Pollution Prevention Program to reduce pathogens in runoff, to implement management measures to reduce pathogen runoff, and report to the Regional Water Board on progress made on implementing pathogens-reduction measures.

C. Tomales Bay Watershed Stewardship Plan (2003), created by the Tomales Bay Watershed Council, is a community-based watershed plan that was written to address human activities that effect water quality and the habitats of Tomales Bay and its watershed. The goals of the Plan are to:

- Ensure water quality in Tomales Bay and its tributaries is sufficient to support natural resources and beneficial uses;
- Restore and preserve the integrity of natural habitats and native communities; and,
- Develop strategies to implement the Plan and to protect the watershed.

The following actions are required to achieve these goals and include:

1. Develop a coordinated and comprehensive water quality monitoring plan for Tomales Bay and its tributaries;
2. Support implementation of practices and projects that will reduce nonpoint sources of water pollution and enhance habitats in the Watershed;
3. Assess, protect, and restore key habitats for species of local interest; and,
4. Promote and support public outreach and education about Tomales Bay and its watershed.

D. Tomales Bay Water Quality Monitoring Plan (2003) grew out of the Tomales Bay Watershed Stewardship Plan (see Goal 1, above). The Plan was designed to monitor the water quality (i.e., chemical, physical, and biological characteristics of surface waters) in Tomales Bay and tributary streams with the goals of developing long-term trends and identifying source area of concern for water quality management.

E. Tomales Bay Integrated Coastal Watershed Management Plan, (2007), was developed by the Tomales Bay Watershed Council and produced through Proposition 50, Water Security, Clean Drinking Water, Coastal Beach Protection Act of 2002, funding. The Integrated Coastal Watershed Management Plan (ICWMP) joins the Tomales Bay Watershed Council's watershed management efforts with those of the water suppliers (i.e., Bolinas Community Public Utility District, Inverness Public Utility District, Marin Municipal Water District, and North Marin Water District) in the region to comprehensively address the water management issues.

The Tomales Bay Watershed Stewardship Plan (described above), provided the foundation from which ICWMP objectives were identified. Preparation of the ICWMP involved a review and summation of all existing plans, reports and technical studies to identify key Watershed management issues. These key management issues include:

1. Watershed assessment for the four Areas of Biological Significance in the region;
2. Evaluation of municipal stormwater management networks and source area and condition of stormwater facilities; and,

		3. Implementation of a septic outreach and education program.
k	Restoration Work	Background (1960s – 1998) The Gambonini mine is the major source of mercury loading to the Walker Creek Watershed. The mine operated from the 1960's to the early 1970's. Although mining and ore processing ceased in 1972, the waste containment structure for the mine, an earthen dam built across a steep canyon channel, failed catastrophically in the winter of 1982 because of improper design. Mine waste, stored behind the earthen dam, was released downstream inundating Walker Creek and its floodplains with mercury-laden waste and debris. Episodic mine waste discharges to Walker Creek continued unabated until the mine was remediated in 1998-2000. Data show that the mercury mine waste polluted a 16-mile stretch of Walker Creek, from the Gambonini mine to its terminus in Tomales Bay and that mercury-bound sediments remain stored at depth, in the bed, bank, and flood plain deposits of Walker Creek. Soulajule Reservoir is a secondary source of mercury within the Walker Creek watershed. Soulajule Reservoir, built in 1976, discharges to Walker Creek and was built in the Arroyo Sausal sub-watershed, which includes two former mercury mines. Mercury levels in fish caught in Soulajule Reservoir are elevated as compared to fish caught in other Bay Area reservoirs that do not contain mine waste. Gambonini Mine Site Cleanup (1998-2000) The Gambonini Mine site was cleaned up and stabilized in 1998 - 2000 through a U.S. EPA Superfund action. Mine site remediation focused on minimizing the runoff of mercury-laden sediment from the mine site by using a combination of geotechnical engineering, bio-stabilization, re-vegetation, channel reconfiguration, and runoff control techniques to isolate the mining waste from stormwater. Site remediation successfully cut off the source of the mercury-laden sediment to the downstream receiving waters of Walker Creek. Data collected where Walker Creek and Tomales Bay join, the Walker Creek delta, indicate that the mining wastes that were released are being buried by clean surface sediments (natural recovery) now that the primary source of mercury mine waste in the Watershed has been contained and that stormwater at the mine site is properly managed. Therefore, no additional remedial actions are anticipated for either the former Gambonini mine and/or the bed, banks, and floodplain of Walker Creek, beyond implementation of the land management requirements of the Grazing Waiver, the Soulajule Reservoir mercury control actions, and stormwater management per the Industrial Stormwater Permit for the mine site, described below. Walker Creek Mercury TMDL On September 29, 2008, the U.S. EPA approved the Basin Plan amendment incorporating a TMDL for mercury in the Walker Creek and Soulajule Reservoir watersheds. This amendment had been adopted by the Regional

Water Board in January 2007 and approved by the Office of Administrative Law in September 2008.

The goal of the TMDL is to reduce mercury levels in Walker Creek and Soulajule Reservoir so that fish-eating wildlife and humans who consume local sport fish are protected from the toxic effects of this bio-accumulative pollutant. The TMDL allocates discharges of mercury-laden sediment and methylmercury production to sources in the watershed.

The Walker Creek Mercury TMDL relies on control measures to prevent and minimize mercury waste discharges to Walker Creek that include:

- Containment and capping of mercury mine waste and stormwater diversion at the Gambonini mine site (1998-2000);
- Implementation of a stormwater pollution prevention program for the Gambonini mine site under the General Industrial permit;
- Regional Water Board adoption, implementation, and enforcement of a waiver of WDRs for grazing operations in the watershed to control and manage storrmwater discharges (including disturbances to mercury-laden creekside sediments) from grazing operations (Grazing Waiver);
- Issuance of Water Code §13267 requirements to the Marin Municipal Water District to conduct fish tissue and sediment mercury characterization studies in Soulajule Reservoir to be used in the development, evaluation, and implementation of Soulajule Reservoir mercury controls;
- Conditioning CWA Section 401 projects with provisions to minimize mercury discharges and methylmercury production; and,
- Providing landowner assistance through identification of 319(h) grant opportunities and State Cleanup and Abatement account funding for creek restoration projects and implementation of grazing management practices.

Conditional waiver of Waste Discharge Requirements for Grazing Operations (Grazing Waiver)

In 2008, the Regional Water Board adopted a Conditional Waiver of Waste Discharge Requirements for Grazing Operations in the Tomales Bay Watershed (Grazing Waiver). The Grazing Waiver applies to properties in the Walker Creek Watershed and implements the Tomales Bay pathogens TMDL, Walker Creek mercury TMDL, and is expected to serve as early implementation for the Walker Creek sediment and the Tomales Bay mercury, nutrients, and sediment TMDLs that are in process. As noted above, 96 percent of the Walker Creek watershed is in private ownership with dairy grazing as the predominant land use.

For property owners/ranchers of 50 acres or more who graze cattle along Walker Creek, the Grazing Waiver requires ranchers to incorporate grazing management practices that minimize mercury discharges and methylmercury production. The primary goal of the Grazing Waiver for this part of the watershed is to keep cattle out of the Creek so as to prevent remobilization of mercury-laden sediment previously deposited on floodplains and overbanks (see Background, above).

The Regional Water Board identified 241 active grazing parcels 50 acres or greater in size in the Tomales Bay Watershed based on a database provided by Marin County, and ranchers that own or operate on 230 of them have obtained coverage under the Grazing Waiver (95% enrollment rate).

Landowner assistance with the identification and implementation of best management practices (e.g., fencing, bank stabilization, off-channel water sources, road repair, wet crossings, etc.) within the Walker Creek watershed is being carried out by the Tomales Bay Grazing Land Partnership though grants awarded to the Marin County RCD and Point Reyes National Seashore. Grant fund sources include state and federal funds, including Proposition 13, CWA 319(h) and Cleanup and Abatement account funding. Monitoring has been done by the Regional Water Board, SWAMP, and OEHHA (and the Tomales Bay Watershed Council.

Soulajule Reservoir

In 2008, the Regional Water Board imposed CA Water Code §13267 requirements on the Marin Municipal Water District (District), the owner and operator of Soulajule Reservoir, to submit a monitoring and implementation plan and schedule to:

1. Characterize fish tissue, water, and suspended sediment mercury concentrations in the reservoir and Arroyo Sausal Creek; and,
2. Develop and implement methylmercury production controls necessary to attain both in-reservoir and downstream TMDL targets.

At this time, the Soulajule Reservoir studies are in process and there is no additional information on the status of that work to report.

Status of Watershed Improvement Analysis [2]

Based on our existing monitoring data and the Walker Creek watershed improvement actions described above, we believe that the data supports the requirements for Option 2a, based on statistical evidence of watershed-wide improvement.

The Walker Creek Mercury TMDL allocates wasteload and load allocations the following mercury sources in the Watershed as follows:

Source	Wasteload Allocation	Load Allocation
Gambonini Mine site NPDES Permit no. CAS000001	5 mg mercury per kg suspended sediment	
Soulajule watershed and Reservoir		0.04 ng methylmercury per liter water 0.5 mg mercury per kg suspended sediment
Downstream depositional features[1]		0.5 mg mercury per kg suspended sediment
Background[2]		0.2 mg mercury per kg suspended sediment

[1] Applies to sediment released from depositional features (creek beds, banks, and floodplains) downstream of the Gambonini Mine and Soulajule Reservoir.

[2] The background allocation applies to all areas in the Walker Creek watershed outside of the influence of the Gambonini Mine site or Soulajule Reservoir.

Water quality conditions in the Walker Creek watershed are improving. In the decade following mine cleanup, both mine site stormwater (suspended sediment) data and sediment core data collected at the terminus of Walker Creek at Tomales Bay (Walker Creek delta), show significant reductions in mercury loading to the creek and Tomales Bay (see Figure 2 for monitoring locations).

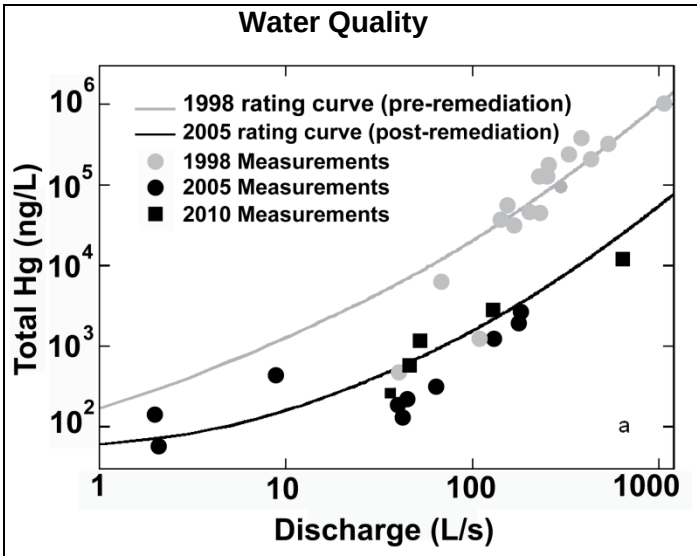
The former Gambonini mine was the primary source of mercury to the Walker Creek. Mining-related mercury loads were measured both as stormwater discharges from the mine and as accumulated sediments at the terminus of Walker Creek, the Walker Creek delta, as follows.

Mine Site Remediation Effectiveness as Evidenced in Stormwater

In early 1998, before mine cleanup, Regional Water Board staff measured suspended sediment and mercury loads from the mine over a two-month, wet, El Niño winter. Kirchner, et al, (2011) calculated that just over this two month period, 135 kilograms (kg) mercury and 2,300 metric tons (MT) sediment were discharged from the Gambonini mine site.

Five years after site cleanup, in early 2005, Regional Water Board staff again measured the suspended sediment and mercury loads being derived from the Gambonini Mercury mine. Kirchner et al.[1] calculated that 0.13 kg mercury and 13 MT of sediment were discharged over two months in this average rainfall year.

[1] Kirchner, J.W., C.M. Austin, A. Myers, and D.C. Whyte, 2011. *Quantifying Remediation Effectiveness Under Variable External Forcing Using Contaminant Rating Curves.* Environmental Science and Technology, 45(18), pp. 7874-7881.

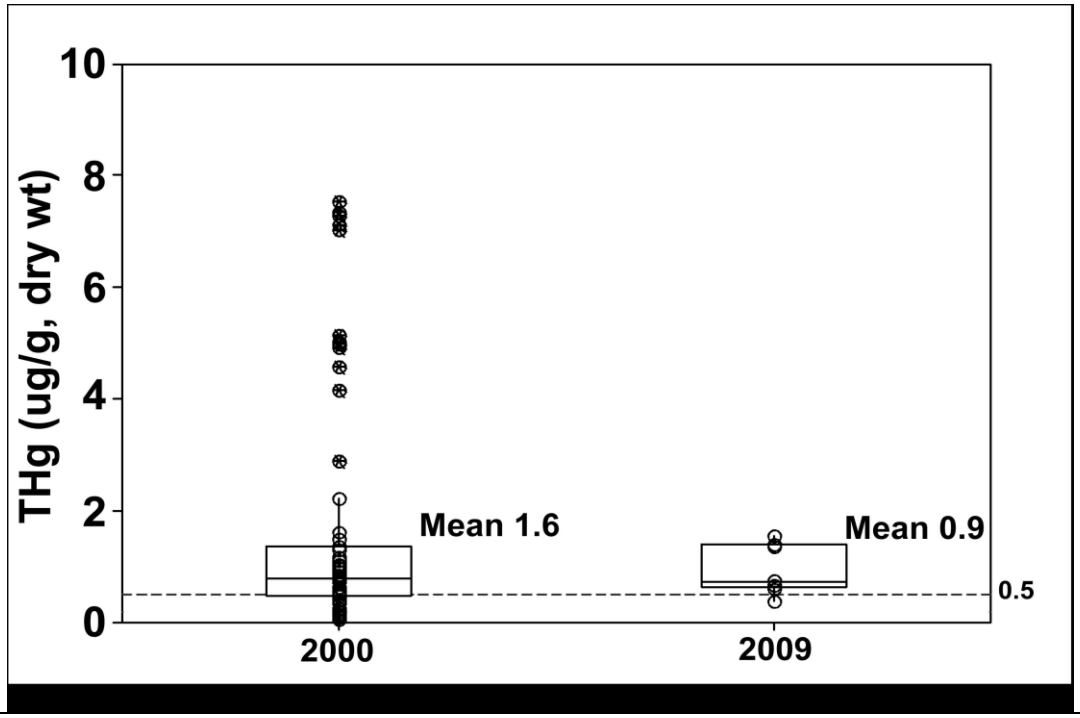


Additionally, Kirchner et al. calculated that if the same storm conditions had occurred in 2005 as had occurred in the 1998 El Niño winter, much higher loads would have been discharged over an equivalent two-month period; Kirchner et al. estimate suspended loads of 9.3 kg mercury and 950 MT sediment. Comparing 1998 to 2005 estimates and holding rainfall constant, mine site cleanup resulted in a 92 to 93 percent mercury load reduction, and 55 to 60 percent sediment load reduction, which indicate effective mine site cleanup.

Mine Site Remediation Effectiveness as Evidenced in Walker Creek Sediment Trends

Regional Water Board staff also studied the effectiveness of mine site remediation through the collection and analysis of sediment cores collected at the depositional apex of Walker Creek, the Walker Creek delta.

Total mercury concentrations is sediment at the Walker Creek delta have declined in the decade since the Gambonini Mercury mine was cleaned up in 2000. Mean total mercury concentrations have reduced from 1.6 to 0.9 mg/kg and the variance (scatter) has also greatly reduced.



Lower variance translates into greater confidence in this downward trend. The significant reduction in sediment loading following mine site cleanup coupled with a greater amount of sediment input from other parts of the Walker Creek watershed, at a background level of 0.2 mg/kg, has allowed for burial and natural attenuation of the mercury signature over time. Therefore, we predict that the total mercury concentration in sediment will decrease to no more than 0.5 mg/kg, the allocation set for the downstream depositional features in the Walker Creek Mercury TMDL. Rate of decline and timing will be dependent on rainfall events and are therefore difficult to predict. However, mercury levels will continue to be monitored in sediment and fish tissue as part of TMDL implementation, with the goal of meeting the proposed targets within 20 years of the effective date of the TMDL.

In summary, the positive water quality outcomes evidenced at Walker Creek include:

- Mine site cleanup was a success and has resulted in a 92-93 percent mercury load reduction and 55-60 percent sediment load reduction to Walker Creek.

- Total mercury and methylmercury concentrations in sediment cores at the Walker Creek delta have showed statistically significant declines since mine cleanup in 2000.

- Implementation of grazing management practices (e.g., streambank stabilization, creek fencing, etc.) required under the Grazing Waiver should further limit remobilization of mercury-laden sediments along the streambanks, beds, and floodplains along the mainstem of Walker Creek. Currently, 95% of active ranches are enrolled in the grazing waiver program, with a 97% compliance rate based on reports submitted and NPS staff inspections.

- Continued improvement (less methylmercury in biota and in the Walker Creek delta) is expected because the benefits of the mine site cleanup near the top of the watershed are still making their way along Walker Creek to its terminus in Tomales Bay. It is expected that downstream depositional features will reach 0.5 mg/kg mercury per kilogram sediment allocation by 2032.

Although the downstream Tomales Bay is also listed as impaired by mercury, no additional implementation actions to address this listing are foreseen at this time because of the success of the mercury and sediment control actions undertaken for the Walker Creek Mercury TMDL. However, the results of ongoing monitoring programs in the watershed will be used to inform the next steps in future restoration efforts.

In conclusion, the Walker Creek watershed is impaired by mercury, nutrients and sedimentation. Significant improvements in mercury have been realized. However, implementation efforts, primarily via the grazing waiver will continue to move toward full restoration of this watershed.

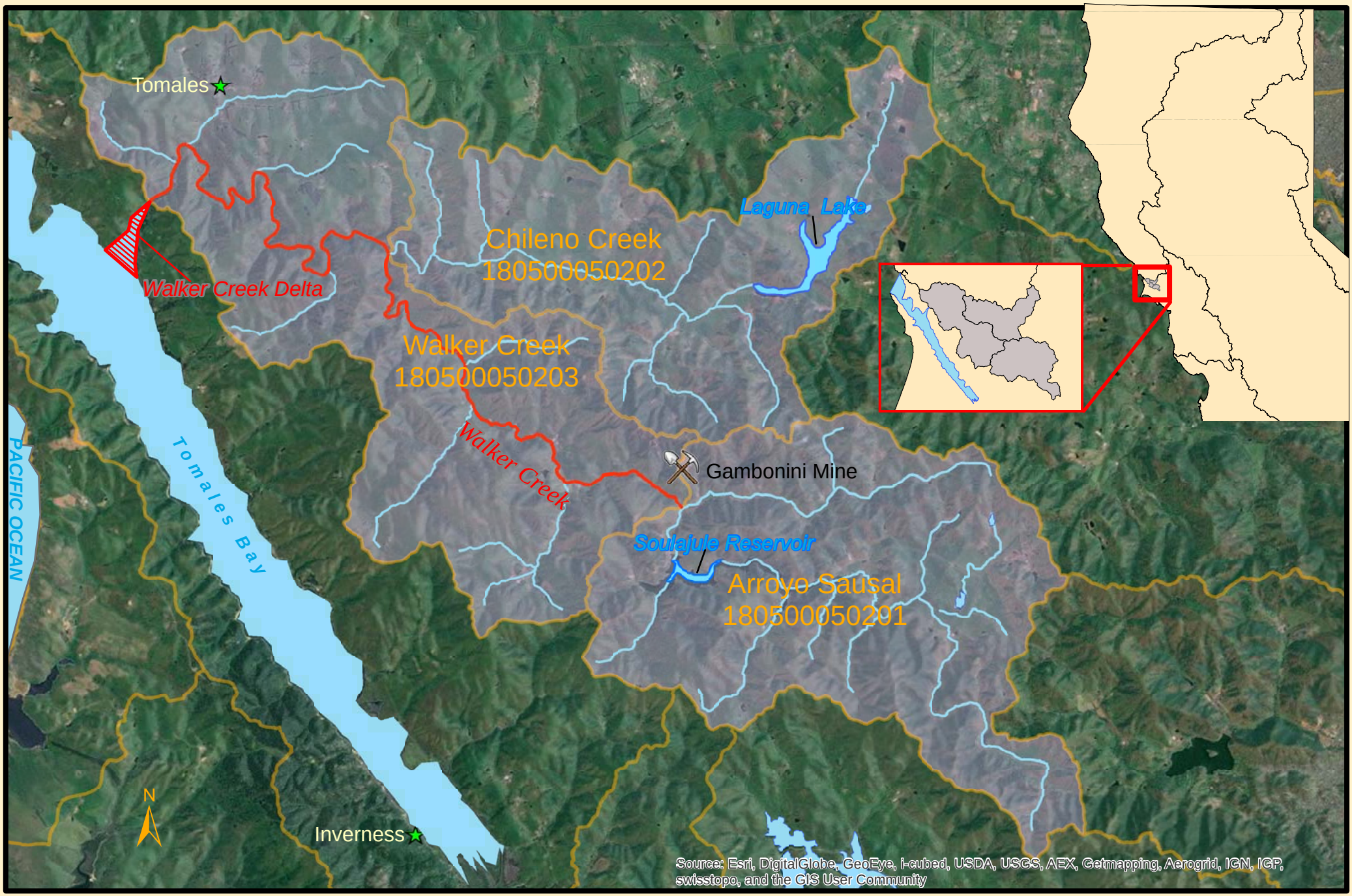


Figure 1: Improvements in Mercury Impaired Walker Creek Watersheds

0 0.5 1 2 Miles

- Walker Creek Improved Reach
- Creeks
- Walker Creek Watershed
- HUC 12 Border

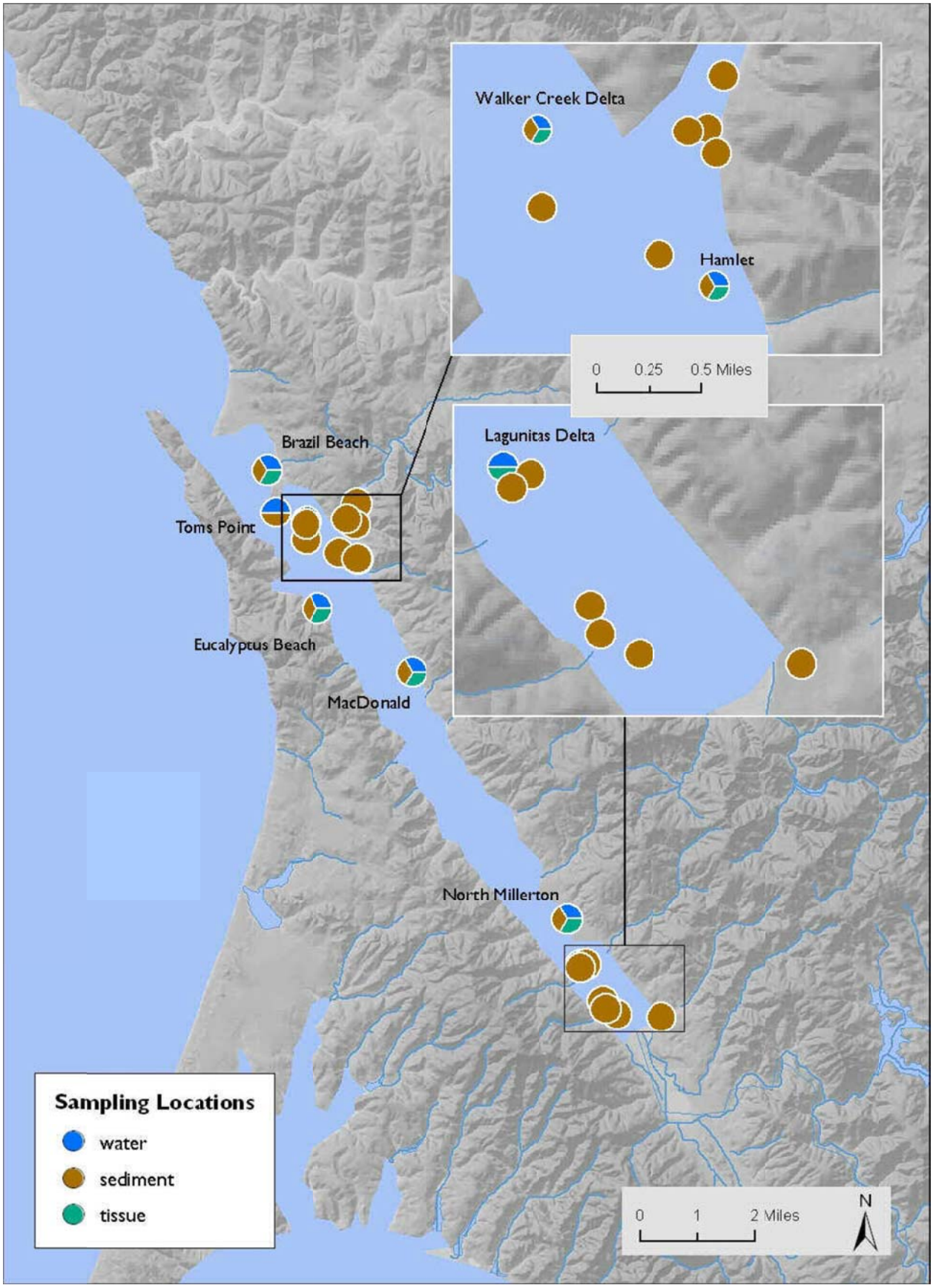


Figure 2: Tomales Bay Mercury Monitoring Locations

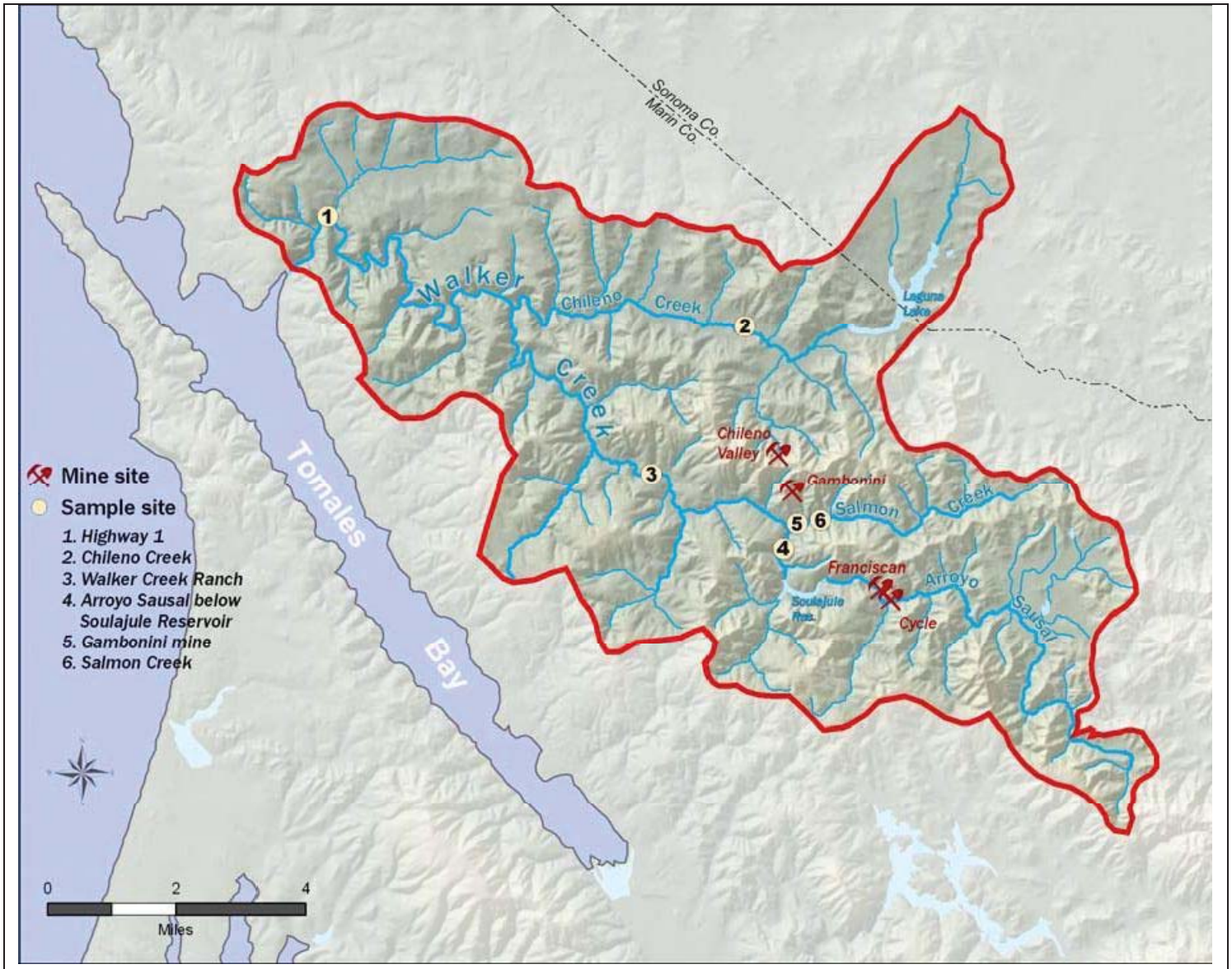


Figure 3: Mercury Mines and Water Sampling Locations

The Salmon Creek sampling point is upstream of any mining influences. A USGS gage and a continuous suspended solids data logger are located at Walker Creek Ranch.