AUGUST 2016

sierra HERITAGE

A Lake *with No Name*

Mercury **Wars**

Cadet Rifle *Team*

Malakoff Mine – Hydraulic Mining Scene (circa 1872). Over a cubic mile of sediment was processed during its peak 20 years of operation. This amount of sediment yielded 1 million ounces of gold. The historic hydraulic mine operations and others in the northern Sierran region contributed significantly to the creation of widespread environmental problems since the 1870's, including sediment loading in watersheds and mercury contamination Courtesy of US Geological Survey (Carlton Watkins Collection)

MERCURY WARS

BY DAVID LAWLER AND HANK MEALS

The controversy between miners and environmentalists over mercury contamination and the use of gold-suction-dredges in the Sierra Nevada region has been simmering for over a decade, but its roots lie buried in 19th century mining conflicts between hydraulic miners and California farmers. The constant discharge of huge quantities of hydraulic mine tailings had caused repeated flooding and destruction in the ranching and farming communities of Marysville and Yuba City, and seasonal flooding was severe enough by the 1870s to bury entire orchards under a thick blanket of mud and silt.

The downstream effects were equally devastating for river navigation. The ports at Marysville and Yuba City were rendered all but useless for commercial shipping when mine tailings and sediment made riverbeds too shallow for large vessels to travel beyond Sacramento. Until then Marysville had served as the transportation and logistics hub of gold mining in the northern Sierra, ever since the Gold Rush began in 1849.

Hundreds of hydraulic mines in the northern Sierra region were aligned along the route of the ancient Yuba River system, one of the world's oldest and richest sources of gold. Over $30 billion of placer gold was extracted from this ancient river system during the previous 165 years. This incredible amount of gold product was mainly produced by industrial-scale hydraulic mining and bucket-line dredging technologies.

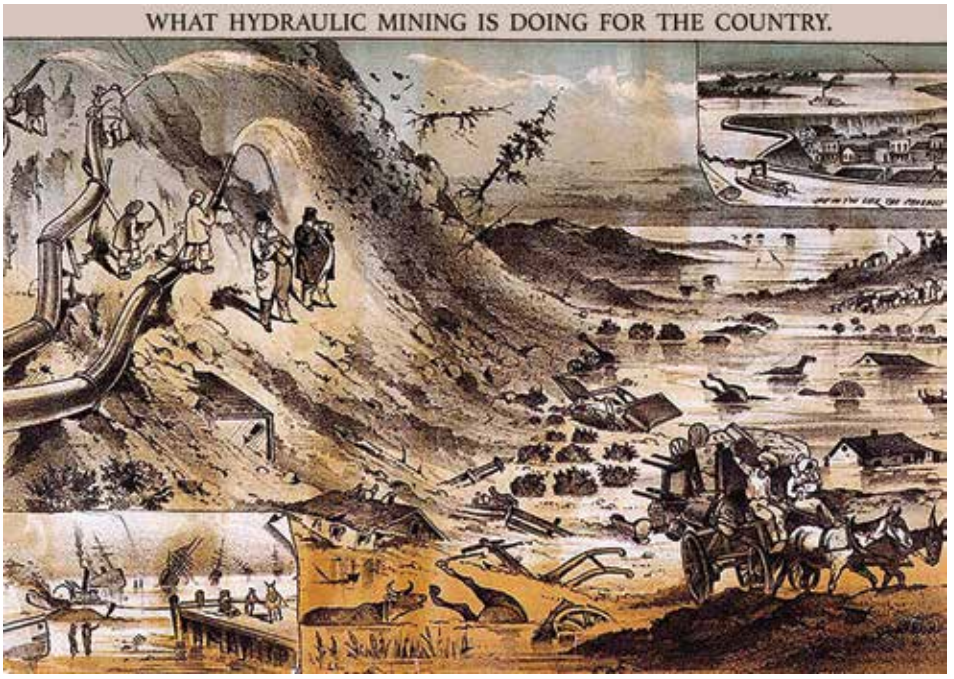
While the hydraulic mining industry in the Sierra Nevada was widely considered a financial success during its reign, it produced hundreds of millions of tons of mine waste, which subsequently devastated the fisheries and riparian communities along river systems flowing into the Sacramento River watershed. Hydraulic mine waste also contained millions of pounds of toxic mercury. "Quicksilver," as the miners termed it, was thought to be essential for profitable recovery of placer gold. Over 50 million pounds of mercury were transported from the mercury mines in California's coast range and then applied in placer gold recovery technologies at thousands of hydraulic and lode mine sites throughout the Sierra. An estimated 30% to 50% of the elemental mercury was lost as a result of

Steamboat Linda advertisement – Marysville/ Yuba City transport of goods and passengers. Steamships were unable to travel up the Sacramento and lower Yuba River starting in the 1870's, due to vast influx hydraulic mine tailings clogging the riverbed Courtesy of California State Library

inefficient mining practices and ended up in the state's waterways.

Hydraulic operators vigorously defended themselves and their industry against the Sacramento Valley agricultural community and its political allies. For a while they used arguments like "first in right," describing themselves as the original pioneers and developers of the Sierra region, prior to the arrival of farmers. They claimed an "irrevocable right" to mine or exploit placer gold resources, regardless of damages inflicted on local or regional agricultural communities by their activities.

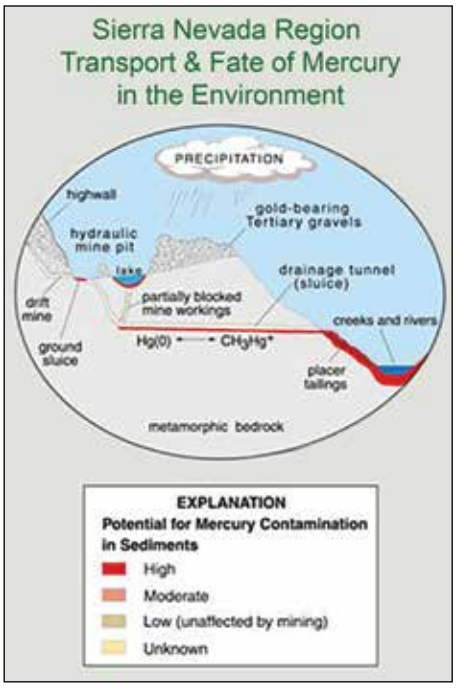
Miners also asserted that because they had paid for and built the water systems that collected, stored and distributed water to the mines, they had a time-honored right to control those resources. Hydraulic mines required vast amounts of water to effectively extract the deep gold-bearing gravels of the ancestral Yuba River system. The water had to be conveyed from large reservoirs through hundreds of miles of ditches, flumes and



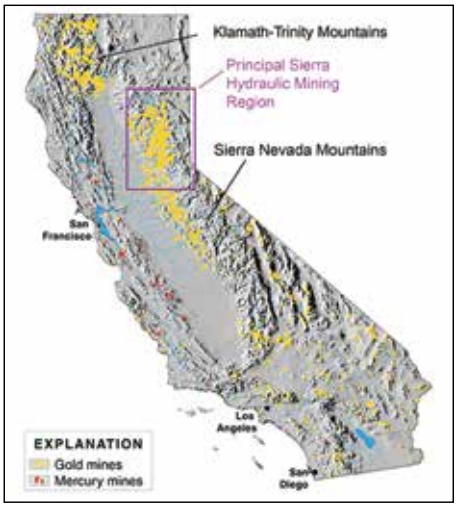
Anti-Hydraulic Mining Political Cartoon. Emotions ran high between the Sacramento Valley farming communities and hydraulic mine owners, leading to lawsuits against the hydraulic mine owners, starting in the 1870's. These legal actions culminated in the 1884 Sawyer decision to prohibit unrestrained or direct discharge of hydraulic mine tailings within all tributaries of the Sacramento River Watershed in the northern Sierra Nevada region Courtesy of California State Library

Ruby Mine – Gold Collection, Sierra Co. CA. Display at Los Angeles County Museum of Natural History Courtesy of North Bay Resources

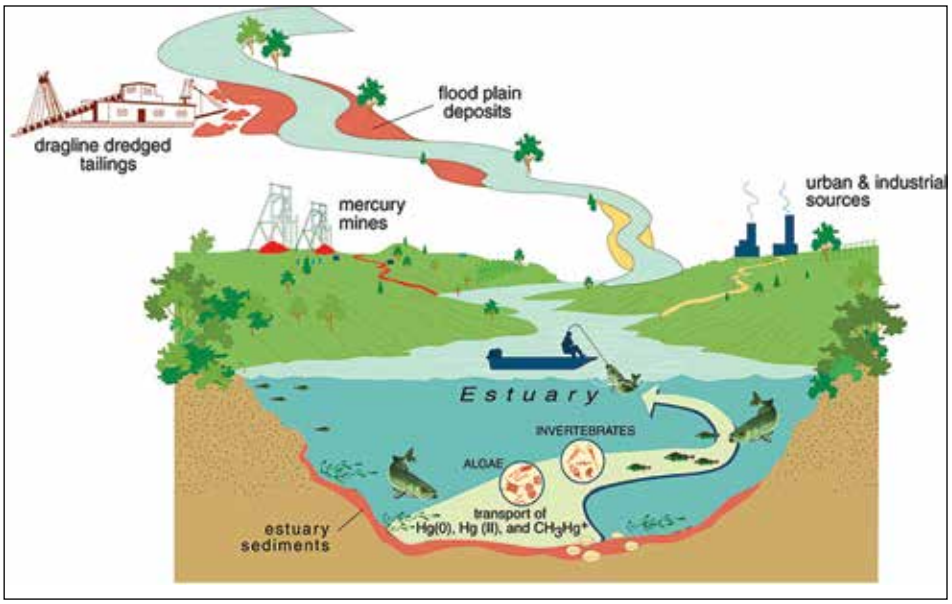
Hydraulic mine. Sluicebox gold recovery system shown in photo with "undercurrent" design. Historic sluicebox systems discharged a significant amount of mine tailings into streams and rivers on a daily basis Courtesy of California State Library



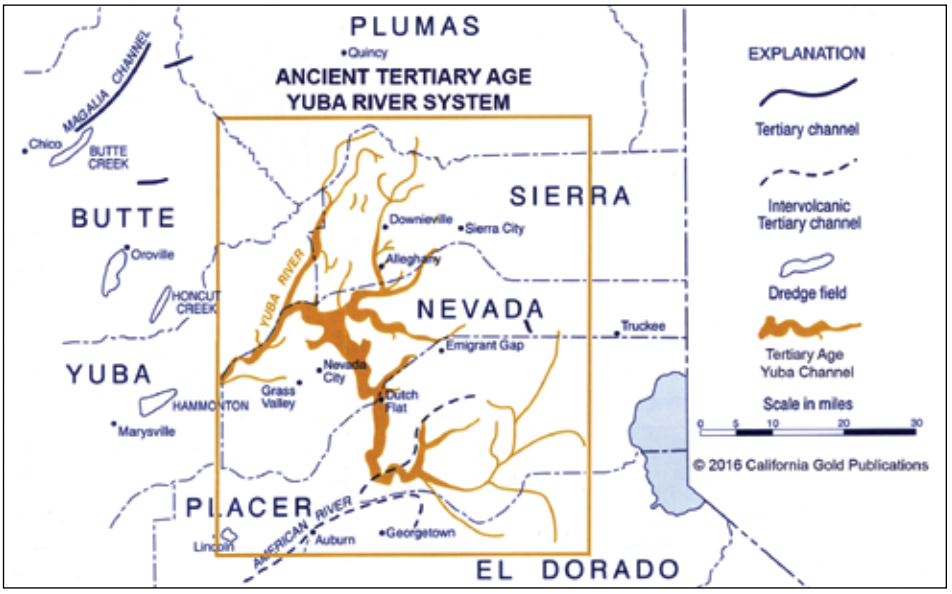
Mercury "Fate and Transport" illustration, depicting transport of "fugitive" or mercury lost during historic hydraulic mining operations. Subsequently, mercury particles are transported from the upper portions of the Sierran watersheds during winter storm events and thence into lower elevation rivers, reservoirs and wetlands. Note that hydraulic mine sluicebox tunnels and "ground sluices" are key mercury "hot spot" sites Courtesy of US Geological Survey



California State – Principal mercury and gold Mining Districts Courtesy of US Geological Survey



Mercury "Fate and Transport" illustration, depicting transport of "fugitive" or mercury lost during historic hydraulic mining operations it's transport from Sierran rivers to the San Francisco Bay and Delta region. Also depicted is the chemical transformation of elemental mercury to toxic organic mercury or methyl mercury Courtesy of US Geological Survey



Ancient (Early Tertiary Age) Yuba River Map. The ancient Yuba River system was a major source of placer gold production in the Sierra Nevada region during the 19th century Courtesy of California Gold Publications

canals to each mining operation.

While it has been argued that 19th century mine operators were not aware of the environmental consequences of their activities, historical evidence proves otherwise. For example, at Foresthill Divide the owner of one hydraulic mine admitted in a letter that "if the local farmers could see the turbid conditions on the Middle Fork of the American River that we are creating from discharge of hydraulic mine tailings into the river they would be furious."

Judge Lorenzo Sawyer's *Decision of 1884* ended traditional hydraulic mining and caused the California legislature to enact the nation's first environmental law. Its purpose was to prevent further environmental devastation along five rivers and their associated watersheds, namely the Feather, Yuba, Bear, American and Consumnes river systems.

Initially, few mine owners complied with the newly imposed regulations. Hydraulic mining operations were frequently conducted during

the winter season, when water was plentiful and the streams naturally carried more siltation. This made compliance inspection by State monitors more problematic. During the summer and fall seasons some owners chose to conduct outlawed activities at night to allow more time for the turbid water discharged into local streams and rivers to clear up.

In response to the 1884 Sawyer decision, mine owners formed a formidable group known as the Hydraulic Miners Association, which eventually succeeded in getting hydraulic mining reinstated nine years later. The *Caminetti Act of 1893* was a political compromise that authorized construction of dams designed to retain hydraulic mine tailings. The California Debris Commission was formed to monitor hydraulic mine operations and mine tailings, and each mine operator was charged a fee for tailings storage.

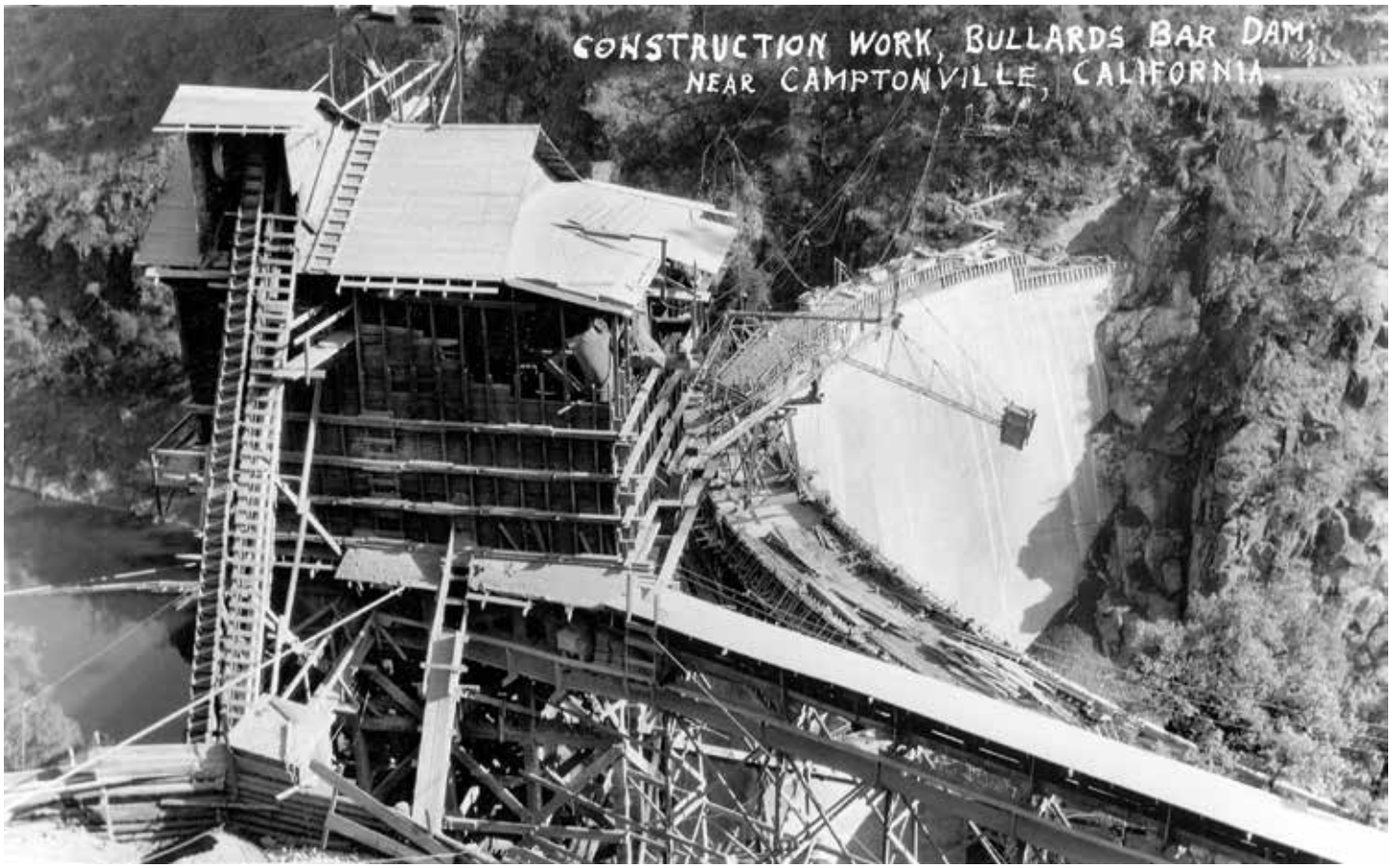
For various reasons such dams failed to solve the problem and their reservoirs ended up being entirely used for water storage and recreational purposes. Most notable of these dams and associated reservoirs are Englebright and the Bullards Bar Dam on the Yuba River, and the Combie and Camp Far West dams on the Bear River. The administrative duties of the California Debris Commission were later taken over by the federal Army Corps of Engineers.

Over the last 15-years, an interdisciplinary, interagency team headed by the U.S. Geological Survey (USGS) has been evaluating the effects of hydraulic mining and mercury contamination on the environment in the Northern Sierra Nevada region. The net results of these careful scientific investigations have been the documentation of numerous adverse environmental impacts caused by mercury contamination, both to Sierra watersheds and downstream into the San Francisco Bay-Delta environments.

The investigation reveals that the real culprits, which had gone largely unnoticed, were sulfate-reducing bacteria that are nearly invisible to the naked eye. These ancient bacteria can digest metallic elements and compounds. This taxonomic group of

Red Dog Mine. Sluice tunnel – pilot mercury "cleanup" project. Red Dog, Nevada Co. CA. The scaffolding supports "slusher" mine equipment that was used to remove mercury-laden sediment from the floor of the sluice tunnel and transport it to the mouth of the tunnel. The tunnel sediment was then processed to recover the elemental mercury Courtesy of Lawler Collection

Red Dog Mine - pilot mercury "cleanup" project. Nevada Co. CA. Photo of elemental mercury recovered from processing of sluicebox tunnel mercury-laden sediments Courtesy of Lawler Collection



Bullards Bar dam "construction phase" (circa 1926). Bullards Bar dam was the one of the principal Dams constructed by the California debris Commission to restrain hydraulic tailings in the Yuba River watershed Courtesy of Pauly Collection

bacteria is thought to have evolved soon after the Earth was formed nearly 4.6 billion years ago. Sulfate-reducing bacteria require no oxygen and presently thrive in environments that are anaerobic (devoid of oxygen). They are thought to have been instrumental in producing the Earth's oxygen-rich atmosphere by metabolization of sulfate-rich rocks.

In the Sierra Nevada region, colonies have been found living in sluice tunnels and blocked pit lakes, and in the river-bottom sediments of streams, rivers, and reservoirs. The bacterial colonies convert inorganic elemental mercury to an organic form called methyl mercury, which is soluble in water and easily accumulates in the living tissues of all organisms in the food chain. This process is called biomagnification. Top predators in the aquatic and terrestrial food chain are adversely affected, including fish, birds and humans.

Since mercury is classified as a neurotoxin, pregnant women, fetuses, women of child-bearing age and children under six years of age are thought to be most at risk when consuming certain species of fish that dwell in the Sierra-Bay-Delta region.

Several federal government agencies have responded to the mercury threat by implementing pilot projects over the last fifteen years. All three agencies implemented pilot-scale mercury projects at hydraulic mine sluice tunnel sites. Significant amounts of elemental mercury escaped out of the surface and underground sluicebox systems at hundreds of hydraulic mines. The consensus of the technical team was that mercury contamination was considered widespread in the Sierra Nevada region and would be extremely costly to mitigate or clean up.

The initial mitigation strategy focused on mercury clean-up at mercury "hot spots" associated with hydraulic mine features like sluice tunnels. State regulators, including the California Water Quality Control Board, have been ordered to protect State water resources and prevent contaminants from adversely affecting local communities and wildlife.

For example, the Sacramento River Basin Plan calls for preventing "new" inputs or discharges of mercury into the basin. In some cases State agencies have co-sponsored and co-funded federal mercury investigations in order to better assess mercury "fate and transport" in Sierra and Coast Range watersheds.

The projected cost estimates for repairing the environmental damage to watersheds and biota from the Sierra watersheds to the Bay-Delta are enormous. From an economic "cost/benefit" historical perspective, it may ultimately cost two to five ounces of gold for every ounce of gold that was produced in the past by hydraulic mining.

Small miners and some mining groups feel their "mining rights" have been curtailed or restricted, and claim these rights were

guaranteed under the federal General Mining Law of 1872. Enactment of a recent State law that restricts the use of suction-dredge and other mine equipment technologies is regarded by them as *prima facie* evidence that environmentalists are conspiring to take away their hard-won mining rights.

The use of suction dredges to recover mercury from streams and rivers has been proposed by certain mining groups, but unfortunately, standard suction dredge technology is not designed to recover micron- or submicron-size mercury particles.

The local mining community has not been supportive of pilot mercury cleanup projects to date. Knowledgeable miners realize there could be thousands of sluicebox tunnels that could have discharged mercury into rivers, streams and reservoirs. Such miners consider mercury clean-up projects would be a waste of taxpayer dollars. This speaks to much larger public policy and political issues, such as what is the proper role and responsibility of the state and federal government to "clean up" abandoned mine land sites with "point or non-point" sources of mercury pollution.

Creating practical solutions to remove mercury from the environment will be costly and time-consuming, but there is no better time in Sierra history than now to start. Inventors in the recreational mining community can develop new types of equipment that efficiently recover gold but don't discharge toxic tailings into rivers and streams. Effective removal of mine tailings and associated mercury on a regional scale could take centuries.

The sand and gravel industry may be in the best position to extract "fugitive mercury." Most of the large aggregate producers on Sierra river drainages already reprocess hydraulic and bucket line dredge tailings and "unofficially" recover significant amounts of mercury previously lost by hydraulic mining operations. However, some aggregate companies fear their commercial operations might be restricted or shut down if they had to report their recovery of large amounts of mercury to state regulators. SH

Hydraulic mine operations, French Corral, Nevada Co. Ca Courtesy of Nevada County Historical Society