# Friends of the North Fork

Comments on and Evidence of Water Quality Impacts
of Instream Suction Dredge Gold Mining

Submitted to the State Water Resources Control Board
Public Workshop
June 12, 2007

# Friends of the North Fork

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Ms. Tam M. Doduc, Chair
Mr. Charles R. Hoppin, Member
California State Water Resources Control Board
Division of Water Quality
1001 I Street
Sacramento, Ca 95814

Dear Ms. Doduc and Mr. Hoppin:

The following are the comments of Friends of the North Fork on the effects of suction dredge mining on water quality, submitted in connection with the June 12, 2007 SWRCB public workshop on this issue. Our comments focus on mercury pollution, increased turbidity levels and miscellaneous erosion and fire issues. While our experience has been on the North Fork of the American River, the issues we raise are found on rivers statewide.

Friends of the North Fork previously submitted a legal memorandum on the failure of state and federal agencies to regulate suction dredge mining, and we wish that memorandum to be incorporated as comments in connection with this proceeding, as well.

For the North Fork of the American and several similarly situated rivers, the most urgent issue is the "flouring" and resuspension of mercury caused by suction dredging activities. Studies by your staff have found that suction dredging is an "unacceptable" method for mercury removal because, while the typical suction dredge removes most of the mercury that passes through its riffles, mercury in the fines and sediments lost from the dredge are so laden with "floured" mercury that they are a hazardous waste.

As the state agency responsible for protecting the state's water quality and enforcing the Clean Water Act, you cannot allow this to continue. This is the Water Board's responsibility, and you cannot rely on a 1994 Department of Fish and Game environmental impact report that barely even mentioned water quality issues.

We are asking that you issue an immediate cease and desist order directed at the Department of Fish and Game. That order should:

1. Immediately halt all dredging activities in rivers downstream of historic hydraulic mining pits and abandoned mine sites that are leaching mercury into the watershed.

2. Stop the issuance of any additional 2007 dredge permits and any new permits in 2008 and beyond until an adequate environmental review has been conducted and regulations put in place that deal with the broad range of issues that were not addressed in the 1994 EIR.

Sincerely,

Alison Harvey

Alison Harvey
Friends of the North Fork

# *MERCURY*

Comment and Exhibit 1: **During the California gold rush, miners used some 13 million pounds of mercury to enhance gold recovery. It is estimated that between 5 and 6 million pounds of this mercury were lost into the watersheds of the Sierra Nevada region.** *Contributions of Mercury to California's Environment from Mercury and Gold Mining Activities – Insights into the Historical Record. Ron Churchill, California Geological Survey, 2000.*

Comment and Exhibit 2: **Major placer and hard rock mines and hydraulic mining sites in the Sierra Nevada were concentrated in four watersheds: The American, the South Yuba/Bear, the North/Middle Yuba, and the Feather.** *Mercury Contamination from Historical Gold Mining in California, Charles N. Alpers, et al, United States Geological Service, 2005. Mercury Contamination from Hydraulic Placer-Gold Mining in the Dutch Flat Mining District, California, Michael P. Hunerlach, et al, United States Geological Service, 1999.*

Comment and Exhibit 3: **An estimated 200,000 pounds were lost every year into the drainage of the North Fork of the American River from hydraulic mining activities and hard rock mines.** *Information from Dutch Flat historian Russell Towle, 2007*

Comment and Exhibit 4: **It is still relatively easy to find quantities of liquid elemental mercury in sediments and stream channels. Of greater concern is the presence of methyl mercury, a potent neurotoxin that accumulates and magnifies in the food chain.** *Mercury, United States Geological Service, California Water Science Center, 2007.*

Comment and Exhibit 5: **Sufficient methyl mercury is found in the American River watershed that the state advises limited consumption of fish, particularly for women of childbearing age and children under 17.** *California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, 2004.*

Comment and Exhibit 6: **It is unacceptable to encourage suction dredge miners to "clean up" mercury from streambeds because while the typical dredge recovers a high amount of the mercury that passes through it, mercury that is lost in the dredging process is "floured" and broadcast downstream in a form that is ten timeshigher in mercury concentration than that needed to classify it as a hazardous waste.** *Mercury Losses and Recovery, Division of Water Quality, State Water Resources Control Board, Rick Humphries, 2005.*

Comment and Exhibit 7: **The California Department of Fish and Game regulations for instream suction dredge mining and the Environmental Impact Report justifying them do not address the impact of suction dredge mining on the resuspension and dispersion of floured mercury. The FEIR merely states that "Fish and Game Code Section 5650 addresses pollution of this nature." Section 5650 does not address methyl mercury pollution.** *Mercury discussion from CDFG FEIR on suction gold dredging regulations, 1994. Fish and Game Code Section 5650.*

# Exhibit 1

# CONTRIBUTIONS OF MERCURY TO CALIFORNIA'S ENVIRONMENT FROM MERCURY AND GOLD MINING ACTIVITIES—INSIGHTS FROM THE HISTORICAL RECORD


**By**

**Ronald Churchill**

**California Department of Conservation**

**California Geological Survey (formerly the Division of Mines and Geology)**


*A Paper Presented At:*

Assessing and Managing Mercury from Historic and Current Mining Activities


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San Francisco, California

# CONTRIBUTIONS OF MERCURY TO CALIFORNIA'S ENVIRONMENT FROM MERCURY AND GOLD MINING ACTIVITIES—INSIGHTS FROM THE HISTORICAL RECORD

Ronald K. Churchill, Department of Conservation, Division of Mines and Geology, 801 K Street, MS 08-38, Sacramento, CA 95814-3531, Telephone (916) 327-0745, FAX (916) 324-1396, email rchurch@consrv.ca.gov

California environmental mercury issues relate to historical mining operations in two ways. The first is to mercury mining activity. Between 1846 and 1981, about 103.6 million kg of mercury were produced within the state. The second is to historic gold mining activities that took place during the last half of the 19th century and the early 20th century, which depended upon gold recovery processes using mercury. Significant quantities of mercury were lost to the environment during both of these activities. This paper will show that historic records and reports from a variety of sources provide valuable information and insights into how and where these mercury losses occurred. They also allow estimation of the quantity and timing of these losses.

Most of the mercury deposits in California occur within a portion of the Coast Ranges geomorphic province extending from near Clear Lake in the north to Santa Barbara County in the south. Other mercury deposits are present in northwestern California, in the Basin and Range Province, and one small deposit was mined in the Sierra Nevada foothills. From historic records, the California Department of Conservation, Division of Mines and Geology (DOC/DMG) has identified 239 mines with production of at least one flask (34 to 34.7 kg) of mercury. An additional 54 sites may have had small unrecorded production. Based on published and unpublished data from the U.S. Bureau of Mines and DOC/DMG, these mines produced about 103.6 million kg of mercury. As is typical for metallic ore deposits, a few large mines account for most of the mercury production. The 25 largest mines account for about 100 million kg, or about 97 percent, of California's mercury production. The two largest mines, New Almaden and New Idria, account for about half of the total production. Cinnabar (HgS) is the dominant mercury ore mineral in most of these deposits. Some deposits also contain significant occurrences of metacinnabar (also HgS in composition) and, in a few instances, native mercury. Many mercury deposits were originally found by the recognition of the presence of silica-carbonate rock, a topographically prominent rock type commonly associated with many mercury deposits. Other deposits were found by panning stream sediments and hillside soils for the presence of cinnabar or native mercury.

Mercury ore processing routinely occurred at the mine sites. Mercury ore processing was relatively straightforward and involved heating the ore in furnaces or retorts to break down the mercury sulfide ore minerals and liberate the mercury vapor. The mercury vapor was subsequently cooled and collected as liquid mercury in a condenser. Some mercury was lost to the environment wherever processing occurred. Mercury losses occurred by absorption into furnace bricks, trapping as fine droplets in solid residue, called soot, that formed in the condensers, as vapor that failed to be trapped in the condensers and exited to the atmosphere, during cleaning of the condensers and by spillage of recovered mercury during handling.

Mercury furnace losses gradually decreased over time as more efficient furnaces and better recovery practices were developed. By 1890, 15-20 percent losses could be achieved at well run plants, but losses at poorly run plants were still as much as 40 percent. By 1917, overall losses were believed to be about 25 percent and by 1950, losses of 5-10 percent were achieved at the best plants (Roush, 1952; Bradley, 1918). If it is assumed that an average furnace loss rate for all mercury ore processed in California is 25 percent, then roughly 34.5 million kg of mercury may have been lost to the environment from historic mercury mining activity. Some mercury lost at these sites was recovered later by processing old furnace bricks in new furnaces, mining and processing soil under old furnace sites, reprocessing soot and tailings piles, and processing gravel downstream of mercury mine sites.

From 1850 until the 1890's, the California mercury mines were the only domestic source of mercury in the United States. During this period, mercury production greatly exceeded domestic need and about 70 percent of the mercury produced in California was exported, primarily to other Pacific Rim countries. Small quantities of mercury were imported during this time but these were probably largely utilized for manufacturing of vermilion, other mercury products, and for felt manufacturing at factories in the eastern United States. A large amount of California mercury was shipped to Virginia City, Nevada, for use in processing the Comstock Lode silver ores. With these exports, little or no foreign imports, and no other domestic mercury sources, it is very unlikely that the amount of mercury available for use in the gold mining industry in California could have exceeded 10.3 million kg during the period 1850 to 1890.

The discovery of gold in the Sierra Nevada Foothills in 1848 marks the beginning of significant gold mining activity in California. The DOC/DMG Minefile database contains approximately 13,500 historic gold mine and gold prospect listings for California. Most of these mines are located in the central and northern portions of the Sierra Nevada, the adjacent easternmost portions of the Great Valley, and the Klamath Mountains geomorphic provinces. Three types of gold deposits are dominant in these areas: 1) unconsolidated surficial placer deposits; 2) weakly to strongly consolidated ancient (buried) placer deposits, and 3) lode (quartz vein) deposits. *(Large low-grade disseminated gold deposits of several types have accounted for most gold production in the state for the last 20 years. Although some of these are located in the Sierra Nevada province, they will not be discussed further because mercury was not used in processing ore from these deposits.)*

Unconsolidated surficial placer deposits were the first gold deposits worked in California. These deposits were largely exhausted by 1858. Some mercury was undoubtedly used and lost in gold recovery from these surficial placers, but no records exist describing the quantities involved. About this time several technological innovations occurred that made the mining of ancient placer deposits and lode (hard rock) deposits practical. For the former, it was the development of a new method of mining called hydraulic mining. For the latter it was improvement in the design of the stamp mill for processing lode ore. Gold recovery in both of these operations depended upon the mercury amalgamation for gold recovery.

Hydraulic mining utilizes a high-pressure stream of water to expose and disaggregate ancient placer gravels. The gold bearing gravel is then transported by flowing water through a series of sluices (wooden troughs). The bottoms of these sluices have perpendicular cleats extending the full width of the sluice. Mercury is placed behind these cleats to trap and hold gold by amalgamation. Sluices used at hydraulic mining operations ranged in size from hundreds to thousands of feet in length. Periodically the flow of water and gravel was stopped, the gold-mercury amalgam from the bottom of the sluice removed, and the gold and mercury recovered by retorting the amalgam. This method of mining reached its peak in the 1870s. Debris deposition and resulting flooding problems downstream of these operations led to a legal decision in 1884 that greatly curtailed the practice of hydraulic mining in the state. Other methods of placer mining that followed hydraulic mining, such as gold dredging, also utilized mercury amalgamation but the mercury loss rates for these methods were much less. Estimates of mercury losses from placer mining are given in Table 1. These loss figures are based upon estimates of the amount of placer gold produced during different periods and published mercury loss rates per ounce of gold produced for different placer mining methods.

Lode gold mining is a mining technique where quartz veins are followed, usually by underground workings. The gold ore in and along the veins is removed and taken to a mill at the surface for processing to recover the gold. The predominant type of mill for processing lode gold ores from the late 1850s to about 1940 was the stamp mill. At the stamp mill, ore from the mine was roughly crushed and then slowly fed into a battery of stamps. A stamp battery consists of a series of adjacent steel rods held in a vertical, rectangular frame. Collars on the rods interact with a type of camshaft that raises the stamps and then let them drop by gravity. The rods are fitted with very heavy cone-shaped metal shoes at the lower end which strike metal dies when dropped, pulverizing any ore caught in between. This process liberates grains of gold from its host quartz. This ore pulverization process takes place in a cast iron trough, called a mortar, which is filled with mercury. The mercury amalgamates with the freed gold and traps it in the mortar. Water moving through the stamp battery removes the finely pulverized quartz and other rock waste from the mortar. This slurry then flows over an inclined table lined with copper sheeting coated with mercury to catch additional fine gold that may not have been trapped in the mortar. Additional mechanical or non-mechanical devices were sometimes employed after the amalgamation tables for further gold recovery or recovery of sulfides containing gold. Periodically, the stamp mill was shut down and the gold-mercury amalgam scraped from the mortar and from the amalgamation tables for gold and mercury recovery by retorting.

Mercury was lost at both hydraulic mining and stamp milling operations. A principle way mercury was lost in both operations was through "flouring." Flouring is a situation where small particles of mercury, generated during the churning action of stamps in the mortar, or turbulent flow of gravel and water in the sluice, are able to float off with the water moving across these devices. Mercury was also lost by leakage through the bottom of sluices, through chemical reactions during ore milling and during retorting to separate gold from amalgam. For hydraulic mining, probably about one pound of mercury was lost for every three or four ounces of gold recovered (Hanks, 1882). Other methods of processing placer deposits recovered 5 to 10 times this amount of gold per pound of mercury lost. Mercury loss at stamp mills gradually decreased over time from about 0.06 pounds of mercury per ton of ore processed in the 1850s to about 0.03 pounds per ton in the 1890s and finally to about 0.004 pounds per ton for the 1930s and later (Preston, 1895; Richards, 1906; Ransom, 1918). Estimates of mercury lost during the processing of lode gold ores by stamp milling are given in Table 2. These losses are based upon estimates of lode gold produced, likely average ore grades during different periods, and published mercury loss rates per ton of lode ore processed.

It is important to note that the use of mercury amalgamation for gold recovery declined significantly between 1890 and 1920, not just in California but nationwide. This decline coincides with the development of the cyanide process for gold ores and a change in character of gold ores as the lode mines deepened. The cyanide process reduced or eliminated the need for gold recovery by mercury amalgamation at some mines. Traditional stamp mill methods did not work well on the deeper, unoxidized ores, and different ore processing methods were often utilized.

Rough estimates of mercury losses due to gold mining activity can be made from available historic information on gold production and mercury loss rates for different mining methods. Based upon the amounts of placer gold produced by different methods and the approximate mercury loss rates for those methods, the amount of mercury lost from all placer gold mining activity in California is probably about 4.5 million kg. About 3.3 million kg (71 percent) of this loss likely occurred between 1859 and 1884, the principal period of hydraulic mining activity in California. Based on the amount of lode gold ore processed during different periods and approximate mercury loss rates for those time periods, the amount of mercury lost in milling of lode gold ore is probably about 1.3 million kg. Roughly 0.5 million kg (40 percent) were lost during the period 1859-1896 and 0.6 million kg (51 percent) were lost between 1897-1934. The total amount of all mercury lost to the California environment from all gold mining activity, the sum of the placer mining and lode mining losses, is about 5.8 million kg. Probably 80 to 90 percent of this amount was lost in the Sierra Nevada geomorphic province. For comparison, the loss of mercury during processing of the Comstock Lode silver ores at Virginia City, Nevada, has been estimated at 6.75 million kg (Miller and others, 1994).

The estimates presented here put into perspective the magnitude of mercury losses from both ore processing at mercury mine sites and historic gold mining in California. While mercury losses from both activities were substantial, it is probable that six or seven times more mercury was released in the Coast Ranges from mercury mining than was released in the Sierra Nevada from former gold mining activities.

References:

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Table 1. Calculated Mercury Loss from Placer Gold Mining Activity in California

| PERIOD | OZ PLACER GOLD* (MILLIONS) | HG LOSS RATE*—OZ GOLD RECOVERED PER POUND HG LOST | MILLION POUNDS HG LOST | MILLION KG HG LOST | PERCENT |
|---|---|---|---|---|---|
| 1848-1858 | 26.2 | 16 | 1.64 | 0.75 | 16.6 |
| 1859-1884 | 21.2 | 3 | 7.09 | 3.22 | 71.1 |
| 1885-1899 | 2.2 | 4 | 0.55 | 0.25 | 5.5 |
| 1900-1934 | 10.8 | 23 | 0.47 | 0.21 | 4.6 |
| 1935-1968 | 7.8 | 34.25 | 0.23 | 0.10 | 2.2 |
| 1969-1976 | 0.0 | 16 | 0.0 | 0.00 | 0 |
| TOTAL | 68.2 | | 9.98 | 4.53 | 100.0 |

*Production data compiled from Hill, 1929; Minerals Resources of the United States (USGS); and Minerals Yearbook (USBM-for example of loss rates see Review of 1940, p. 228) through 1976. Also see loss rates in Hanks (1882).

Table 2. Calculated Mercury Loss from Milling Lode Gold Ore in California

| PERIOD | OZ GOLD** (MILLIONS) | GRADE OZ PER TON | TONS ORE (MILLIONS) | HG LOSS RATE LB PER TON | LBS HG LOST (MILLIONS) | KG HG LOST (MILLIONS) | % |
|---|---|---|---|---|---|---|---|
| 1848-1858 | 0.240 | 1 | 0.241 | 0.0600 | 0.0144 | 0.0065 | 0.5 |
| 1859-1884 | 6.379 | 0.5 | 12.758 | 0.0450 | 0.5741 | 0.2614 | 20.0 |
| 1885-1896 | 5.396 | 0.3 | 17.987 | 0.0313 | 0.5629 | 0.2553 | 19.6 |
| 1897-1934 | 18.335 | 0.25 | 73.343 | 0.0200 | 1.4668 | 0.6653 | 51.1 |
| 1935-1968* | 6.898 | 0.11 | 62.710 | 0.0040 | 0.2508 | 0.1137 | 8.7 |
| 1969-1978* | 0.023 | 0.11 | 0.209 | 0.0040 | 0.0008 | 0.0003 | 0.0 |
| TOTAL | 37.271 | | 167.248 | | 2.8698 | 1.3017 | 99.9 |

*Stamp Mills were widely used until World War II, then gradually replaced by ball mills and rod mills after the war. For these periods on the table, mercury loss has been calculated at stamp mill rate.
**Production data from Hill, 1929; Mineral Resources of the United States (annual USGS publication); and Minerals Yearbook (annual USBM publication). Gold produced from volcanogenic sulfide ores is not included in these totals.

# Exhibit 2

PUBLICATIONS—Fact Sheet 2005-3014 Version 1.1

November 2005

# Mercury Contamination from Historical Gold Mining in California

By Charles N. Alpers, Michael P. Hunerlach, Jason T. May, And Roger L. Hothem

**The PDF for the report is 3,184 kb**

**Errata Sheet**

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Mercury contamination from historical gold mines represents a potential risk to human health and the environment. This fact sheet provides background information on the use of mercury in historical gold mining and processing operations in California, with emphasis on historical hydraulic mining areas. It also describes results of recent USGS projects that address the potential risks associated with mercury contamination.

Miners used mercury (quicksilver) to recover gold throughout the western United States. Gold deposits were either hardrock (lode, gold-quartz veins) or placer (alluvial, unconsolidated gravels). Underground methods (adits and shafts) were used to mine hardrock gold deposits. Hydraulic, drift, or dredging methods were used to mine the placer gold deposits. Mercury was used to enhance gold recovery in all the various types of mining operations; historical records indicate that more mercury was used and lost at hydraulic mines than at other types of mines. On the basis of USGS studies and other recent work, a better understanding is emerging of mercury distribution, ongoing transport, transformation processes, and the extent of biological uptake in areas affected by historical gold mining. This information has been used extensively by federal, state, and local agencies responsible for resource management and public health in California.

## Gold Mining History

Vast gravel deposits from ancestral rivers within the Sierra Nevada contained large quantities of placer gold, derived from the weathering of gold-quartz veins. Gold mining evolved from hydraulic mining of unconsolidated placer deposits in the early days of the Gold Rush, to underground mining of hardrock deposits, and finally to large-scale dredging of low-grade gravel deposits, which in many areas included the tailings from upstream hydraulic mines.

By the mid-1850s, in areas with sufficient surface water, hydraulic mining was the most cost-effective method to recover large amounts of gold. Monitors (or water cannons, fig. 1) were used to break down placer ores, and the resulting slurry was directed through sluices (fig. 2). As mining progressed into deeper gravels, tunnels were constructed to facilitate drainage and to remove debris from the bottom of hydraulic mine pits. The tunnels also provided a protected environment for sluices and a way to discharge processed sediments (placer tailings) to adjacent waterways. Gold particles were recovered by mechanical settling in troughs (riffles) within the sluices and by chemical reaction with liquid mercury to form gold-mercury amalgam. Loss of mercury during gold processing was estimated to be 10 to 30 percent per season (Bowie, 1905), resulting in highly contaminated sediments at mine sites, especially in sluices and drainage tunnels (fig. 3). From the 1850s to the 1880s, more than 1.5 billion cubic yards of gold-bearing placer gravels were processed by hydraulic mining in California's northern Sierra Nevada region. The resulting debris caused property damage and flooding downstream. In 1884, the Sawyer Decision prohibited discharge of hydraulic mining debris to rivers and streams in the Sierra Nevada region, but not in the Klamath-Trinity Mountains (fig. 4), where such mining continued until the 1950s.

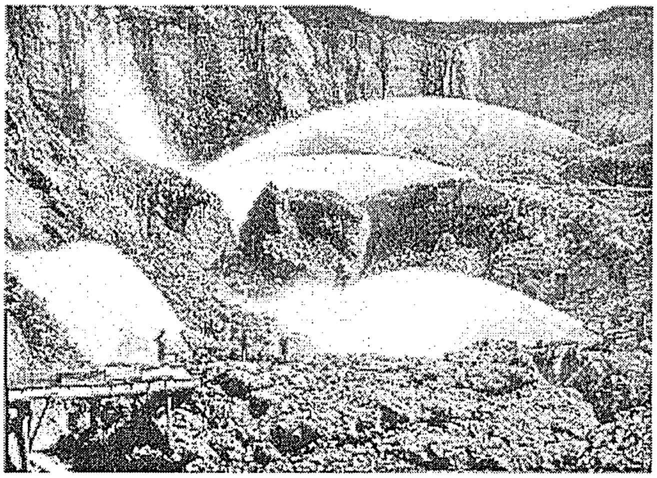

**Figure 1.** Monitors (water cannons) were used to break down the gold-bearing gravel deposits with tremendous volumes of water under high pressure. Some mines operated several monitors in the same pit. Malakoff Diggings, circa 1860.

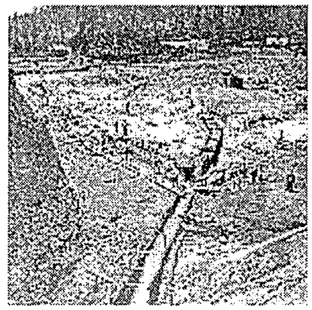

**Figure 2.** Gravel deposits were into sluices (from center to lowe figure) where gold was recovere

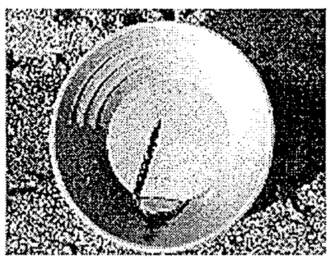

**Figure 3.** Gold pan with more than 30 grams of mercury from 1 kilogram of mercury-contaminated sediments collected in a drainage tunnel.

Underground mining of placer deposits (drift mining) and of hardrock gold-quartz vein deposits produced most of California's gold from the mid-1880s to the 1930s. Another important source of gold from the late 1890s to the 1960s was gold-bearing sediment, which was mined using dredging methods. More than 3.6 billion cubic yards of gravel was mined in the foothills of the Sierra Nevada, where the dredging continued until 2003.

## Mercury Mining

Most of the mercury used in gold recovery in California was obtained from mercury deposits in the Coast Range on the west side of California's Central Valley (fig. 4). Total mercury production in California between 1850 and 1981 was more than 220,000,000 lb (pounds) (Churchill, 2000); production peaked in the late 1870s (Bradley, 1918). Although most of this mercury was exported around the Pacific Rim or transported to Nevada and other western states, about 12 percent (26,000,000 lb) was used for gold recovery in California, mostly in the Sierra Nevada and Klamath-Trinity Mountains.

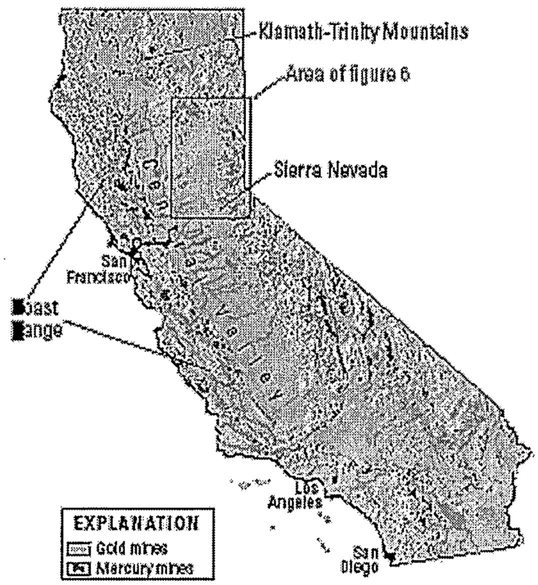


**Figure 4.** Locations of past-producing gold and mercury mines in California. Source: MAS/MILS (Minerals Availability System/Mineral Information Location System) database compiled by the former U.S. Bureau of Mines, now archived by the USGS.

## Use and Loss of Mercury in Gold Mining

To enhance gold recovery from hydraulic mining, hundreds of pounds of liquid mercury (several 76-lb flasks) were added to riffles and troughs in a typical sluice. The high density of mercury allowed gold and gold-mercury amalgam to sink while sand and gravel passed over the mercury and through the sluice. Large volumes of turbulent water flowing through the sluice caused many of the finer gold and mercury particles to wash through and out of the sluice before they could settle in the mercury-laden riffles. A modification known as an undercurrent (fig. 5) reduced this loss. The finer grained particles were diverted to the undercurrent, where gold was amalgamated on mercury-lined copper plates. Most of the mercury remained on the copper plates; however, some was lost to the flowing slurry and was transported to downstream environments.

Gravel and cobbles that entered the sluice

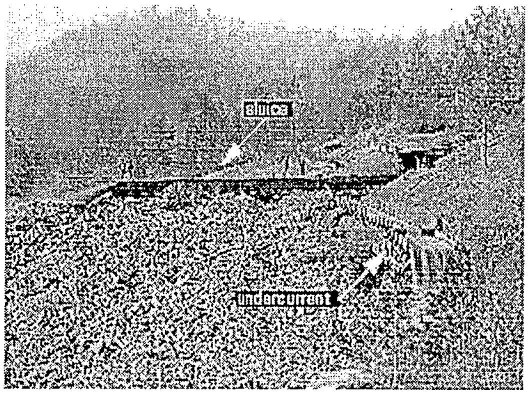


**Figure 5.** Undercurrent in use, circa 1860, Siskyou County, California.

at high velocity caused the mercury to flour, or break into tiny particles. Flouring was aggravated by agitation, exposure of mercury to air, and other chemical reactions. Eventually, the entire bottom of the sluice became coated with mercury. Some mercury was lost from the sluice, either by leaking into underlying soils and bedrock or being transported downstream with the placer tailings. Minute particles of quicksilver could be found floating on surface water as far as 20 miles downstream of mining operations (Bowie, 1905). Some remobilized placer sediments, especially the coarser material, remain close to their source in ravines that drained the hydraulic mines.

Mercury use in sluices varied from 0.1 to 0.36 lb per square foot. A typical sluice had an area of several thousand square feet; several hundred lb of mercury were added during initial start-up, after which several additional 76-lb flasks were added weekly to monthly throughout the operating season (generally 6 to 8 months, depending on water availability). During the late 1800s, under the best operating conditions, sluices lost about 10 percent of the added mercury per year (Averill, 1946), but under average conditions, the annual loss was about 25 percent (Bowie, 1905). Assuming a 10- to 30-percent annual loss rate, a typical sluice likely lost several hundred pounds of mercury during the operating season (Hunerlach and others, 1999). From the 1860s through the early 1900s, hundreds of hydraulic placer-gold mines were operated in California, especially in the northern Sierra Nevada (fig. 6). The total amount of mercury lost to the environment from placer mining operations throughout California has been estimated at 10,000,000 lb, of which probably 80 to 90 percent was in the Sierra Nevada (Churchill, 2000).

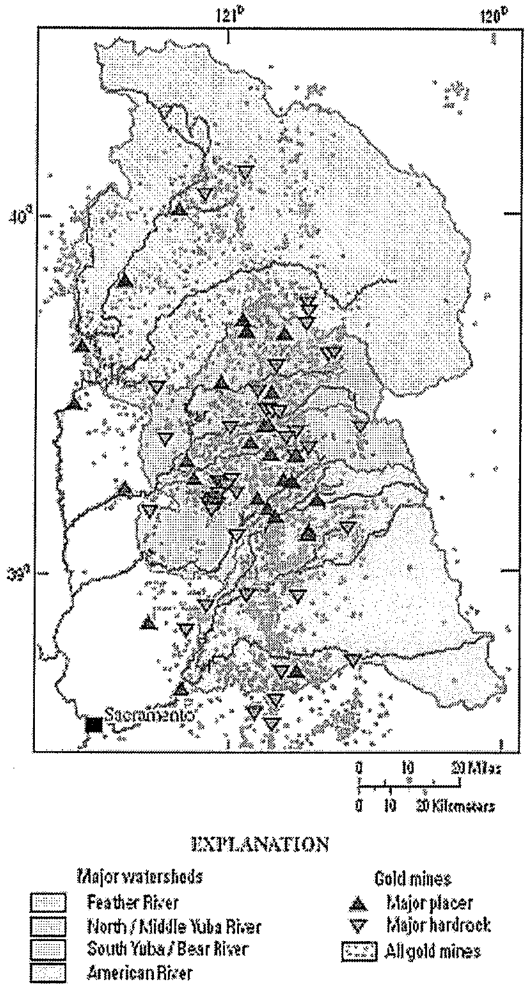


**Figure 6.** Watersheds (also known as drainage basins) in the northwestern Sierra Nevada of California showing past-producing gold mines (as in figure 4) and major placer and hardrock gold mines. Source: USGS Significant Deposits Database (Long and others, 1998).

Historical records indicate that about 3,000,000 lb of mercury were lost at hardrock mines, where gold ore was crushed using stamp mills (Churchill, 2000). Mercury was also used extensively at drift mines and in dredging operations. Mercury was used widely until the early 1960s in the dredging of auriferous sediment from alluvial flood-plain deposits. Today, mercury is recovered as a by-product from small-scale gold-dredging operations; also, mercury and gold are recovered as byproducts from some gravel-mining operations, especially in areas affected by historical gold mining. Understanding the present distribution and fate of the mercury used in historical gold mining operations is the subject of ongoing multi-disciplinary studies.

## The Bear-Yuba Project

In cooperation with federal land-management agencies (the Bureau of Land Management and the U.S. Forest Service) and various state and local agencies, USGS scientists have investigated mercury contamination at abandoned mine sites and downstream environments in the Bear River and Yuba River watersheds (fig. 6) since

1999. Fish from reservoirs and streams in the Bear-Yuba watersheds (fig. 7) have bioaccumulated sufficient mercury (May and others, 2000) to pose a risk to human health (Klasing and Brodberg, 2003). A conceptual diagram (fig. 8) summarizes known mercury sources, transport mechanisms, and bioaccumulation pathways. Based primarily on data from other USGS studies (for example, Saiki and others, 2004), additional fish consumption advisories regarding mercury in other areas of northern California affected by historical gold mining (fig. 9) have been issued.

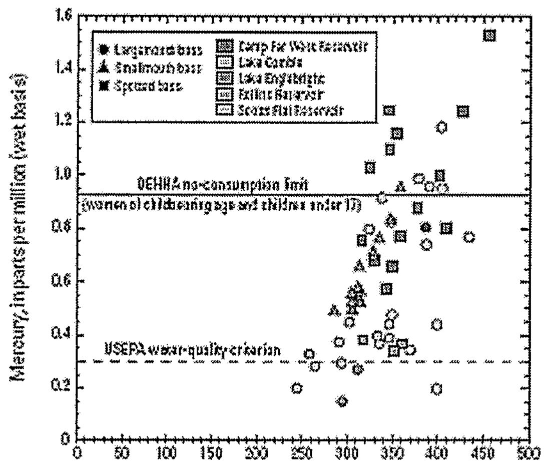


**Figure 7.** Mercury (Hg) concentration in relation to total length for all bass (*Micropterus spp.*) samples collected in 1999 from reservoirs in the Bear-Yuba watersheds, California (May and others, 2000). Dashed horizontal line at Hg concentration of 0.3 ppm represents criterion for methylmercury in fish tissue for the protection of human health (U.S. Environmental Protection Agency [USEPA], 2001). Solid horizontal line at Hg concentration of 0.93 ppm indicates value above which the state of California recommends no consumption of fish for women of child-bearing age and children under 17 (Klasing and Brodberg, 2003). OEHHA, Office of Environmental Health Hazard Assessment.

The USGS and cooperating agencies have identified several "hot spots" of mercury contamination and bioaccumulation by reconnaissance sampling of water, sediment, and biota at numerous hydraulic mine sites in the Bear-Yuba watersheds (Alpers and others, 2005). Subsequently, some mercury-contaminated mine sites have been remediated by other federal agencies, and remediation plans are being developed for other sites. Mercury contamination has also been investigated in dredge fields at lower Clear Creek (Ashley and others, 2002), the Trinity River, and the lower Yuba River (Hunerlach and others, 2004). These investigations show that total mercury concentrations in dredge tailings tend to be most elevated in the finest grained sediments. The State of California has listed several water bodies in the Bear-Yuba watersheds as impaired with regard to beneficial uses, starting a regulatory process that may include eventual mercury-load reduction through Total Maximum Daily Loads (TMDLs). The USGS is providing data and information to stakeholders through ongoing studies of mercury and methylmercury loads in the Bear River, mercury fluxes from reservoir sediments (Kuwabara and others, 2003), mercury methylation and demethylation processes in sediment, and mercury bioaccumulation in the food web of Camp Far West Reservoir.

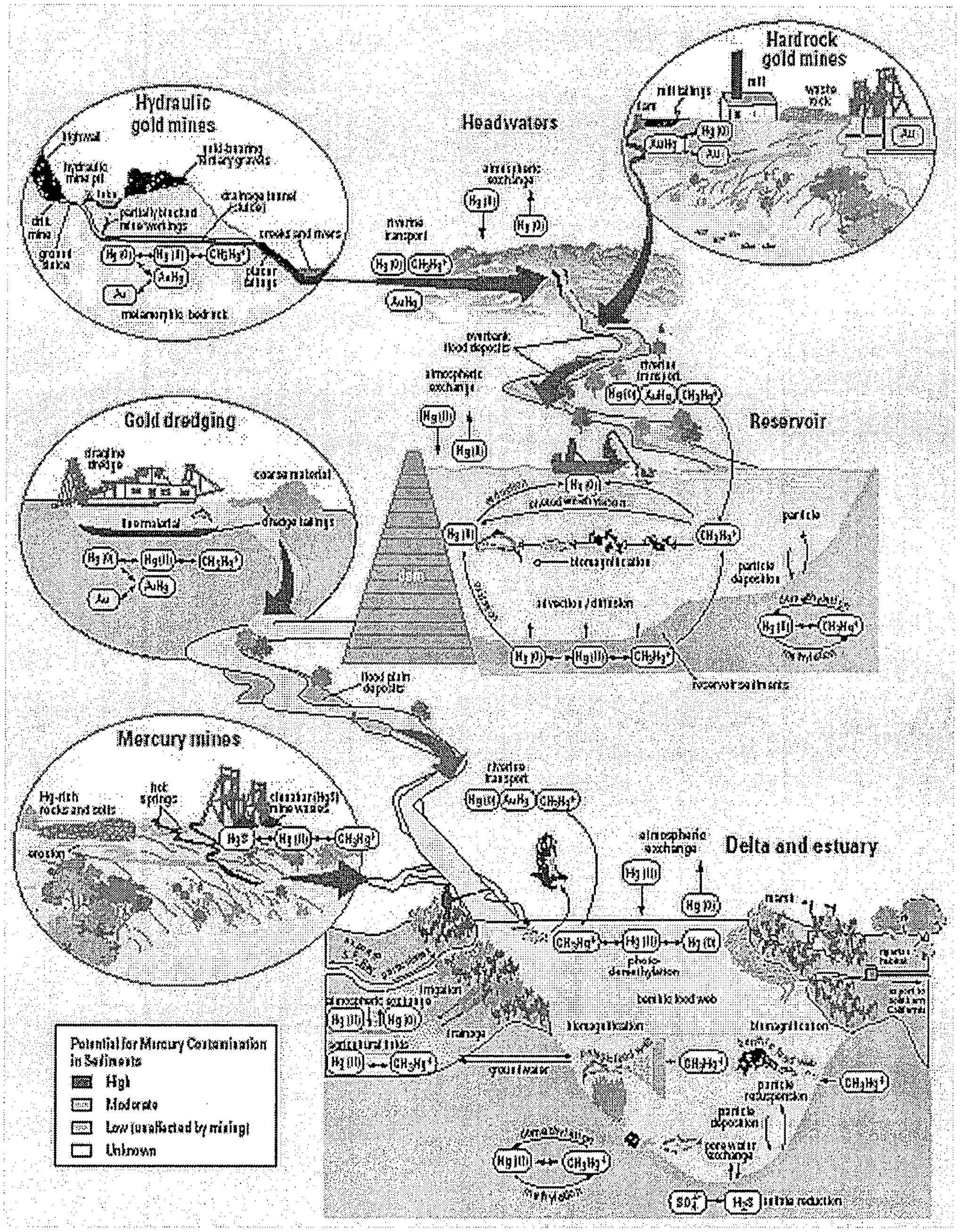


**Figure 8.** Schematic diagram showing transport and fate of mercury and potentially contaminated sediments from the mountain headwaters (hydraulic, drift, and hardrock mine environments) through rivers, reservoirs, and the flood plain, and into an estuary. A simplified mercury cycle is shown, including overall methylation reactions and bioaccumulation; the actual cycling is much more complex. Hg(0), elemental mercury; Hg (II), ionic mercury (mercuric ion); HgS, cinnabar; $CH_3Hg^+$, methylmercury; Au, gold; AuHg, gold-mercury amalgam; $H_2S$, hydrogen sulfide; $SO_4{}^{2-}$, sulfate ion; DOC, dissolved organic carbon. Mark Stephenson (California Department of Fish and Game) contributed to the development of this diagram.

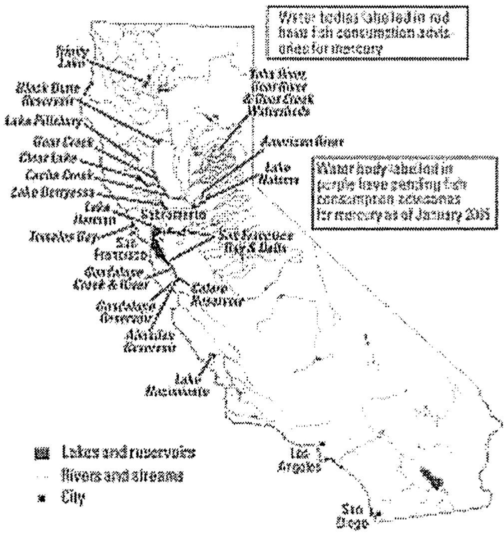


**Figure 9.** Locations of health advisories for mercury in sport fish consumed in California. Source: California Office of Environmental Health Hazard Assessment, accessed October 12, 2005 (http://www.oehha.ca.gov/fish.html).

# MERCURY AND ABANDONED MINES: KEY ISSUES

## Risks to Human Health

- Consumption of contaminated fish
- Improper handling of contaminated sediments
- Inhalation of mercury vapors
- Municipal drinking water supplies generally safe
- Some mine waters unsafe for consumption

## Challenges for Land Management

- Public access to contaminated areas
- Physically hazardous sites
- Environmental consequences of resource development
- Remediation of affected sites

## Environmental Fate of Mercury

- "Hot spots" at mine sites
- Contaminated sediments
- Transformation to methylmercury

- Transport to downstream areas
- Bioaccumulation and biomagnification in food chain

## Mercury Methylation and Biomagnification

*Mercury occurs in several different geochemical forms, including elemental mercury [Hg(0)], ionic (or oxidized) mercury [Hg(II)], and a suite of organic forms, the most important of which is* **methylmercury** *($CH_3Hg^+$). Methylmercury is the form most readily incorporated into biological tissues and most toxic to humans. The transformation from elemental mercury to methylmercury is a complex biogeochemical process that requires at least two steps, as shown in figure 8: (1) oxidation of Hg(0) to Hg(II), followed by (2) transformation from Hg(II) to $CH_3Hg^+$; step 2 is referred to as* **methylation.** *Mercury methylation is controlled by sulfate-reducing bacteria and other microbes that tend to thrive in conditions of low dissolved oxygen, such as near the sediment-water interface or in algal mats. Numerous environmental factors influence the rates of mercury methylation and the reverse reaction known as* **demethylation.** *These factors include temperature, dissolved organic carbon, salinity, acidity (pH), oxidation-reduction conditions, and the form and concentration of sulfur in water and sediments.*

*The concentration of $CH_3Hg^+$ generally increases by a factor of ten or less with each step up the food chain, a process known as* **biomagnification** *. Therefore, even though the concentrations of Hg(0), Hg(II), and $CH_3Hg^+$ in water may be very low and deemed safe for human consumption in drinking water, $CH_3Hg^+$ concentration levels in fish, especially predatory species such as bass and catfish, may reach levels that are considered potentially harmful to humans and fish-eating wildlife, such as bald eagles.*

## *Fish Consumption Advisories for Mercury*

Methylmercury ($CH_3Hg^+$) is a potent neurotoxin that impairs the nervous system. Fetuses and young children are more sensitive to methylmercury exposure than adults. Methylmercury can cause many types of problems in children, including damage to the brain and nervous system, mental impairment, seizures, abnormal muscle tone, and problems in coordination. Therefore, the consumption guidelines in areas where $CH_3Hg^+$ is known to occur in fish at potentially harmful levels tend to be more restrictive for children as well as for pregnant women, nursing mothers, and other women of childbearing age.

In the United States, as of 2003, there were a total of 2,800 fish and wildlife consumption advisories for all substances, of which 2,140 (more than 76 percent) were for mercury. Forty-five states have issued advisories for mercury, and 19 states have statewide advisories for mercury in all freshwater lakes and (or) rivers.

As of October 2005, the state of California had issued fish consumption advisories for mercury in about 20 waterbodies, including the San Francisco Bay-Delta region and several areas in the Coast Range affected by mercury mining (fig. 9; compare with fig. 4). Water bodies with advisories based on USGS fish-tissue data include the Bear River and Yuba River watersheds of the Sierra Nevada (Klasing and Brodberg, 2003), the lower American River including Lake Natoma (Klasing and Brodberg, 2004), and the Trinity Lake area.

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**Cooperating Agencies and Stakeholder Groups**

U.S. Forest Service
Bureau of Reclamation
California State Water Resources Control Board
California Department of Fish and Game
California Bay-Delta Authority
Nevada County Resource Conservation District
Bureau of Land Management
U.S. Environmental Protection Agency
California Department of Parks and Recreation
California Department of Conservation
California Department of Water Resources
Sacramento River Watershed Program

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http://mine-drainage.usgs.gov/
http://toxics.usgs.gov/bib/bib-mercury-on-line.html
http://minerals.usgs.gov/mercury

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# Mercury Contamination from Hydraulic Placer-Gold Mining in the Dutch Flat Mining District, California

By Michael P. Hunerlach, James J. Rytuba, and Charles N. Alpers

U.S. Geological Survey Water-Resources Investigations
Report 99-4018B, p.179-189

## ABSTRACT

Mercury contamination at historic gold mining sites represents a potential risk to human health and the environment. Elemental mercury (quicksilver) was used extensively for the recovery of gold at both placer and hardrock mines throughout the western United States. In placer mine operations, loss of mercury during gold recovery was reported to be as high as 30 percent. In the Dutch Flat mining district located in the Sierra Nevada region of California, placer mines processed more than 100,000,000 cubic yards of gold-bearing gravel. The placer ore was washed through mercury-charged ground sluices and drainage tunnels from 1857 to about 1900, during which time many thousands of pounds of mercury were released into the environment.

Mine waters sampled in 1998 had total unfiltered mercury concentrations ranging from 40 ng/L (nanograms per liter) to 10,400 ng/L, concentrations of unfiltered methyl mercury ranged from 0.01 ng/L to 1.12 ng/L. Mercury concentrations in sluice-box sediments ranged from 600 µg/g (micrograms per gram) to 26,000 µg/g, which is in excess of applicable hazardous waste criteria (20 µg/g). These concentrations indicate that hundreds to thousands of pounds of mercury may remain at sites affected by hydraulic placer-gold mining. Elevated mercury concentrations have been detected previously in fish and invertebrate tissues downstream of the placer mines. Extensive transport of remobilized placer sediments in the Bear River and other Sierra Nevada watersheds has been well documented. Previous studies in the northwestern Sierra Nevada have shown that the highest average levels of mercury bioaccumulation occur in the Bear and South Fork Yuba River watersheds; this study has demonstrated a positive correlation of mercury bioaccumulation with intensity of hydraulic gravel mining.

## INTRODUCTION

Mercury is a potent neurotoxin which has a tendency to biomagnify in the food chain (Krabbenhoft and Rickert, 1995) and is a potential threat to human and ecological health. This research documents previously unrecognized point sources that contain hundreds to thousands of pounds of elemental mercury. Our initial assessment provides information with regard to the specific location of mercury sources in the upper Bear River watershed in the Sierra Nevada region of California (fig.1). Mercury-contaminated watersheds affected by historic placer and hardrock gold mining include extensive public lands managed by the Bureau of Land Management (United States Department of Interior) and the Forest Service (United States Department of Agriculture). The present study is designed to provide a baseline characterization of contaminated areas within the Bear River watershed prior to any remediation efforts. The results of this pilot study may be used to develop a cost-effective, watershed-based approach to addressing regional mercury contamination associated with historic gold mining in the Sierra Nevada.

An abandoned mine in the Dutch Flat mining district, California (fig. 1), which is a highly concentrated point source of mercury impacting the Bear River watershed, was identified as part of the current study. Hydraulic mine tailings are known sources of low concentrations of mercury; however, past studies have failed to locate specific sites with extremely elevated elemental mercury, or *hot spots*. Typically, at streams within deposits of Quaternary age that have elevated mercury, demonstrated point sources can be found, and these hot spots correlate

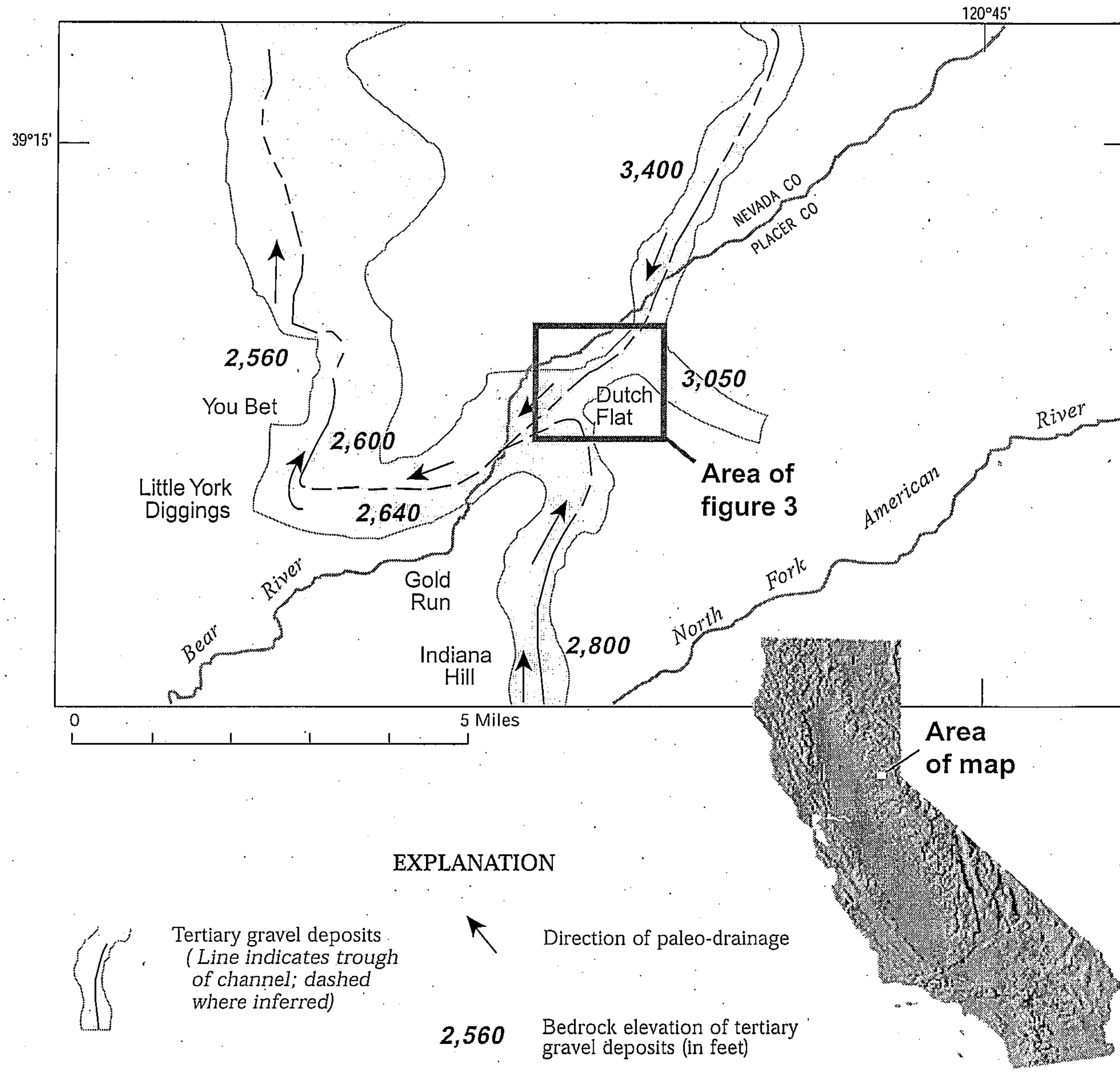


**Figure 1.** Location map showing trace of Tertiary-age river channels in the ancestral Yuba River (modified from Yeend, 1974), California.

with the location of the river channels of Tertiary age where the extensive gravel deposits were exploited for gold by hydraulic mining and where drainage tunnels, sluice boxes, and underground (drift) gravel mines occur.

There are at least five known sluices that discharged hydraulic mine tailings to the Bear River in the Dutch Flat district. Typical 19th century hydraulic gold mining recovery systems used mercury amalgamation to recover gold. Ground sluices and tunnel sluices from hundreds to thousands of feet in length were charged with hundreds to thousands of pounds of mercury. Some of these sluices remain as well-preserved mining artifacts that are easily accessible and actively visited by local miners who attempt to reclaim gold from the remaining amalgam. This activity can expose large quantities of elemental mercury and associated mercury vapors and may pose human health hazards or environmental hazards to downstream surface waters. Mine tailings and placer sediments at abandoned hydraulic placer-gold mines are abundant and fill numerous drainages, ravines, and benches. The presence of large quantities of elemental mercury associated with these sediments indicates that there is a significant potential risk to surface-water quality.

An extensive regional problem exists in watersheds in the northwestern Sierra Nevada because there are numerous drainage basins where placer-gold mining activities have occurred (Larry Walker Associates, 1997). Information collected for this report will help in evaluating other mercury point sources throughout the many hydraulic gold-mining districts in California and elsewhere in the western United States.

In 1998, the U.S. Geological Survey began a water-quality investigation in the Bear River watershed with the following overall objectives: (1) determine the seasonal variability of mercury loading to the Bear River from tunnel and ground-sluice discharges; (2) determine the distribution of mercury in underground mine workings, hydraulic pits, and sluices by mapping and sampling; (3) assess mercury bioaccumulation in aquatic life; and (4) enhance existing databases with detailed information on the occurrence and speciation of mercury associated with hydraulic mining debris in the Bear River watershed, for use in Geographic Information System analysis and watershed planning.

## Purpose and Scope

This report describes a preliminary assessment of the extent of mercury contamination from hydraulic gold mining in the upper Bear River watershed and documents the potential risk to riparian and human health. Data presented include mercury concentrations in water, sediment, and fish tissue; mine discharge measurements; and estimates of total elemental mercury residing in sluice-box sediments. Methyl and total mercury concentrations are reported for selected samples of water (total and filtered) and of sediment to better understand mercury transport and transformation processes.


## Acknowledgments

The authors are grateful to Russell Towle, local author and historian of Dutch Flat, California, for field assistance and information on historical mining practices. The authors also thank Rick Humphreys, California State Water Resources Control Board, and Jason May, USGS, Sacramento, for assisting with field work.


## HYDRAULIC MINING AND MERCURY USE

Placer gold deposits were the first type of gold discovered and mined on a large scale in California. Vast Tertiary-age gravel deposits from ancestral rivers within the Sierra Nevada gold belt region (fig.1) contained large quantities of gold. In 1852, hydraulic mining technology evolved with the use of water canons to deliver large volumes of water that stripped the ground of all soil, sand, and gravel above bedrock. Water was transported through hundreds of miles of ditches, flumes, and pipes up to 36 inches (in.) diameter under pressure of hundreds of pounds per square inch from over 500 feet (ft) of head, and was discharged through a converging 6-to-9 in. nozzle or *monitor*. Powerful jets of water generated through the monitor were used to dislodge and wash away extensive gravel deposits. Some mines operated several monitors in the same pit simultaneously. Hundreds of millions of cubic yards of sediment and water were directed into sluice boxes to separate and recover gold particles by gravity settling. Hydraulic mining was so popular and effective that it outproduced all other types of mining, even by 1900 when hardrock gold mines had been developed throughout the Mother Lode gold belt.

The capability of mercury to alloy with gold has been well known for more than 2,000 years (Rose and Newman, 1986). Mercury was added to large troughs within the sluice boxes to recover the gold as an amalgam. Because such large volumes of turbulent water flowed through the sluices, much of the finer gold and mercury particles were washed through and out of the sluice before they could settle in the riffles. A modification known as an *undercurrent* was developed to address this loss. Essentially a broad sluice, the undercurrent was set on a shallow grade at the side of, and below, the main sluice. Fine-grained sediment was allowed to

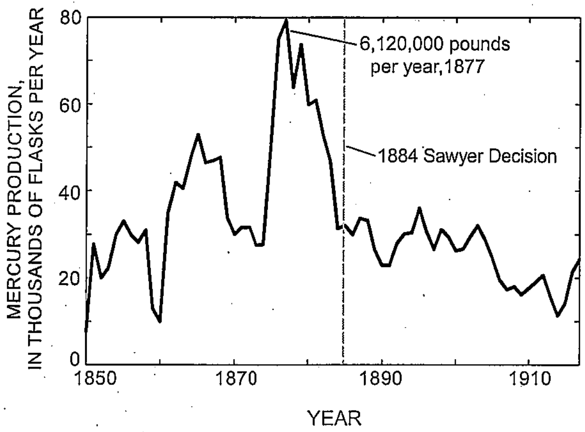


**Figure 2.** Mercury production from the California Coast Ranges, 1850–1917 (modified from Bradley, 1918). (Prior to 1904, one flask equalled 76.5 pounds; starting in 1904, one flask equals 75 pounds)

drop onto the undercurrent, where gold and amalgam were caught (Averill, 1946). Because this method was so efficient, high profits thus realized from hydraulic operations stimulated mining throughout the Sierra Nevada gold belt region and the western United States.

Most of the mercury used in the amalgamation process was obtained from the Coast Range mercury mineral belt on the west side of California's Central Valley. In 1877, mercury mines in the Coast Range reached a peak production of 6,120,000 pounds (lb) of mercury (Bradley, 1918) (fig. 2). Most of this mercury was used for gold recovery throughout the Sierra Nevada and Klamath–Trinity Mountains in California and elsewhere in the western states.

Mercury was introduced and distributed throughout the entire sluice box. Large troughs built into the sluice held hundreds of pounds of elemental mercury and the entire surface of the undercurrents [as much as 5,000 to 10,000 $ft^2$ (square feet)] were at times covered with copper plates treated with mercury. Initial charging rates varied at different mines and as a general rule the upper portions of the sluice boxes were most heavily charged with mercury. More than 1,500 lb of elemental mercury were used in a single sluice at the start of each season (Bowie, 1905). As much as 1,300 lb were added every 12 days due to the loss from the pounding and washing of the gravels passing over the liquid mercury. The specific gravity of gravel [2.7 $g/cm^3$ (grams per cubic centimeter)] is one-fifth that of mercury (13.6 $g/cm^3$), so the gravel would easily float over the mercury while the gold (19.3 $g/cm^3$) would sink into the troughs.

Unclassified gravel and boulders that entered the sluices caused the mercury to *flour*, that is, break into minute, dull-coated particles. Flouring was aggravated by agitation or exposure of the mercury to the air, and eventually the entire length of the sluice box would be coated with mercury. Some of the liquid mercury escaped from the sluice box with the tailings and was transported downstream. Some remobilized placer sediments remain close to their source in ravines that drained the hydraulic mines. Bowie (1905) noted that minute globules of quicksilver were reported floating in surface waters as much as 20 miles downstream of mining operations.

It has been estimated by Averill (1946) and others that under the best operating conditions, 10 percent of the mercury used was lost and, under average conditions, the loss of mercury was up to 30 percent. Estimates of mercury usage vary from 0.1 to 0.36 $lb/ft^2$ (pounds per square foot) of sluice box (Averill, 1946). We estimate that a typical sluice box had an area of 2,400 $ft^2$ (square feet) and used up to 800 lb of mercury during initial start-up with an additional 100 lb added monthly during its operating season (generally 6 to 8 months depending on water availibility). The annual loss of mercury from a typical sluice was likely to have been several hundred pounds.

## HYDROLOGIC SETTING

The Bear River and its tributaries are the primary water resources in the Dutch Flat mining district. Water levels in the Dutch Flat Afterbay fluctuate with the release of water from two hydroelectric powerhouses just upstream of the confluence of the Little Bear River (fig. 3). Both the Bear and Little Bear rivers meander through deeply incised canyons that contain abundant alluvium and terraced placer tailings. Flows into and from the Dutch Flat Afterbay are controlled by the Nevada Irrigation District through a network of forebays, canals, and powerhouse discharges. Flow for the Bear River below the Dutch Flat Afterbay ranged

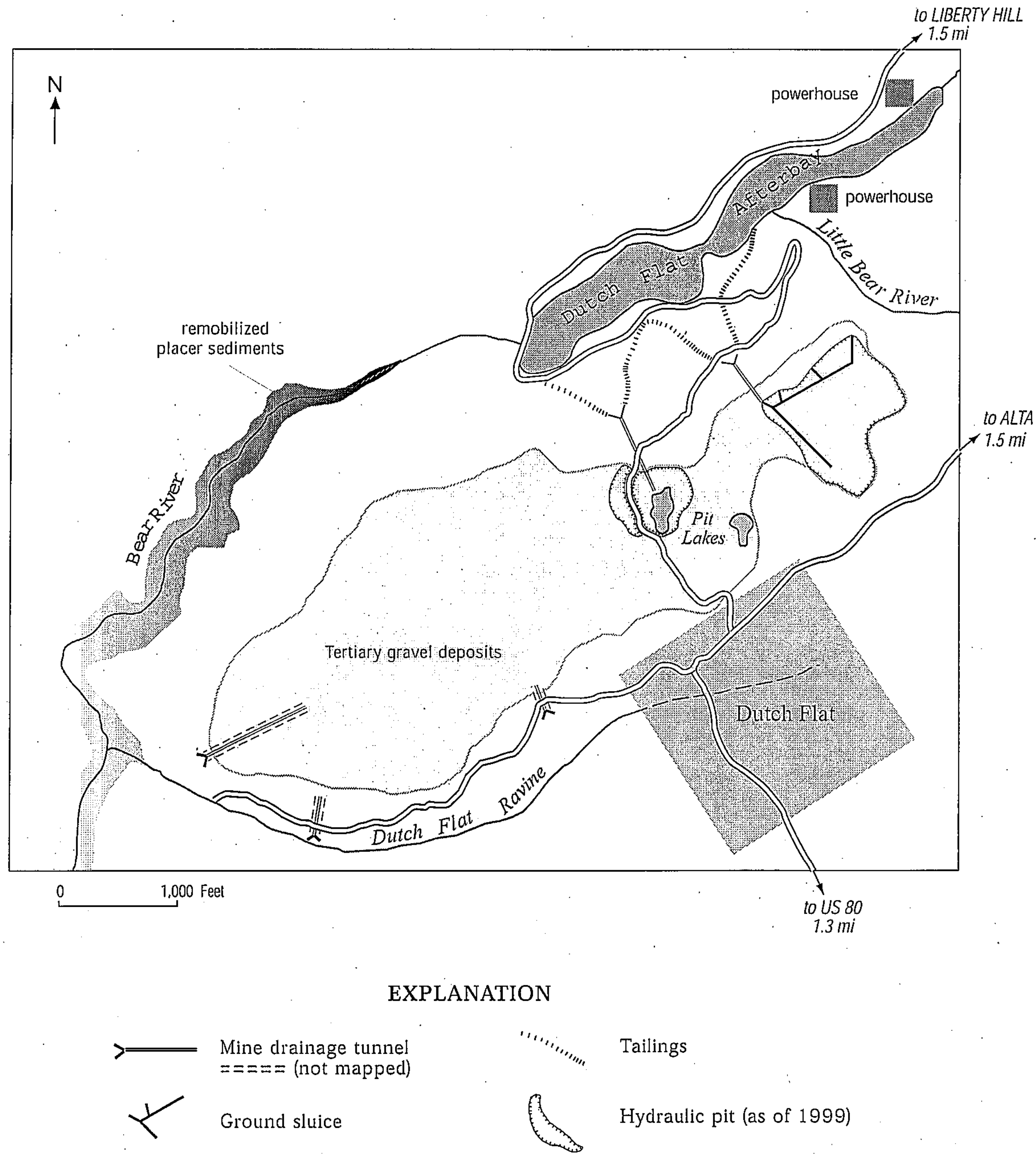


**Figure 3.** Plan view of Dutch Flat mining district, California.

from 6.9 to 494 $ft^3/s$ (cubic feet per second) for the water year October 1997 to September 1998 (W. Morrow, Nevada Irrigation District, written commun., 1998). The Bear River is tributary to the Feather River, which joins the Sacramento River near Verona and then flows into the Sacramento-San Joaquin Delta and San Francisco Bay (fig. 4).

## Geomorphology

Tertiary-age river-channel deposits extend north and south through Nevada and Placer counties of California (fig. 1) (Lindgren, 1911; Yeend, 1974). These quartz-rich, gold-bearing sedimentary channel deposits were part of the large paleo-drainage of the Sierra Nevada that was buried

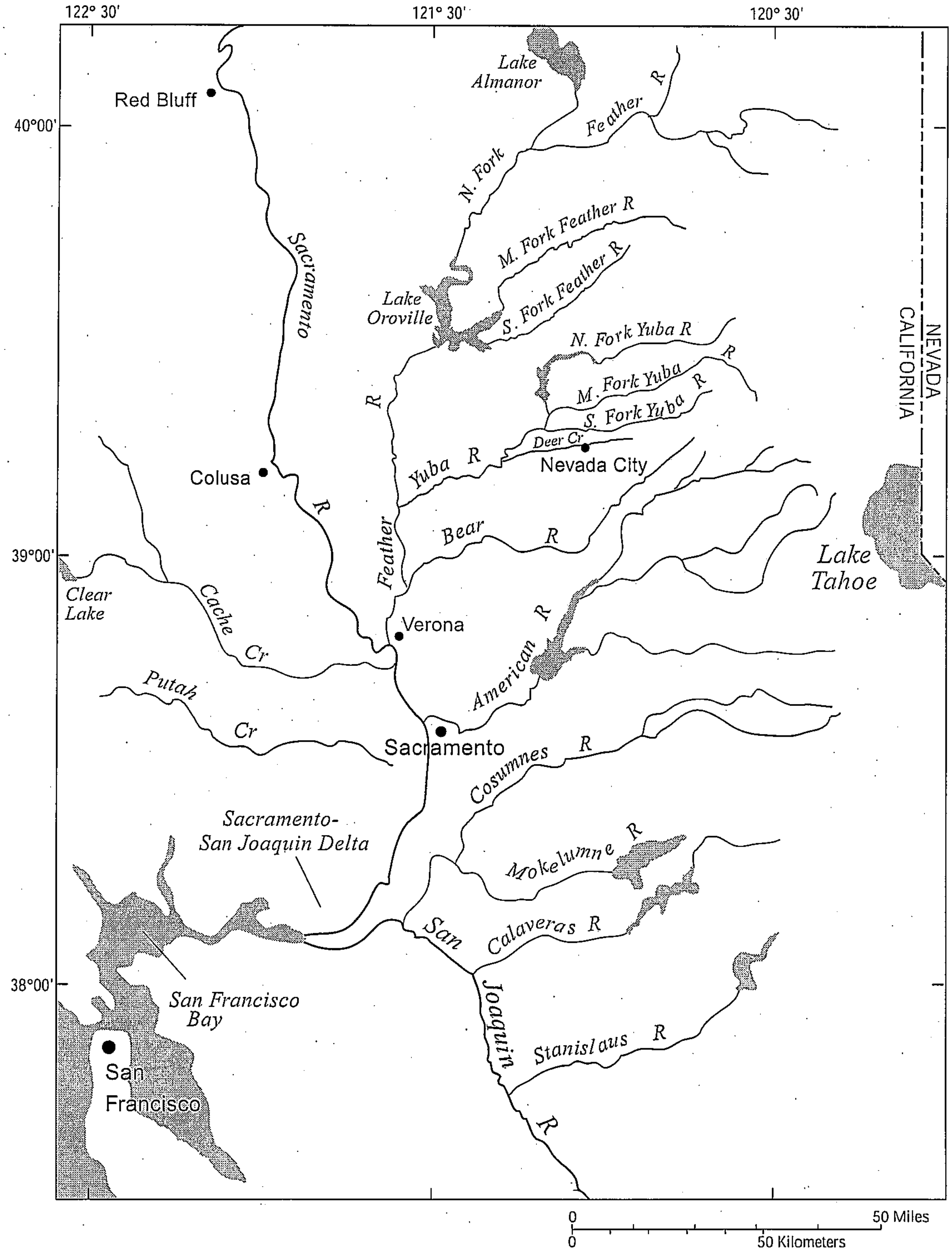


**Figure 4.** Location map showing selected rivers and reservoirs in the Sacramento River watershed, California.

during the Tertiary by volcanic eruptions and related mudflows. Quaternary-age rivers have cut sharp, V-shaped canyons through the volcanic deposits, exposing cross sections of the Tertiary-age river channels during uplift of the Sierra Nevada. Unexposed portions of the Tertiary-age river channels are covered by volcanic rocks that cap the ridges that divide the rivers of the western slope of the Sierra Nevada.

The Dutch Flat mining district covers about two miles of Tertiary-age river-channel deposits that lie sub-parallel to the present-day Bear River drainage (figs. 1 and 3). The district was one of the largest gold producers in California and was developed along the richest sections of the Tertiary-age channel in Placer County, at the junction where three large segments of the Tertiary-age Yuba River system merged. Remaining unworked gravels in the open pits are semi-circular with vertical banks developed as high as 160 ft. The base of the pits expose bedrock that supports little vegetation except for manzanita bushes and sparse pine trees. Pit lakes locally form in areas where the bedrock forms depressions or was excavated to elevations below the grade of tunnel drainage.

### Documentation of hydraulic debris in the Bear River

From 1853 to 1884, unregulated hydraulic mining caused severe aggradation of river channels within the Sierra Nevada with the release of over 1.6 billion yd$^3$ (cubic yards) of sediment and debris (Gilbert, 1917). Natural drainage carried most of the remobilized gravel to the edge of the Central Valley where it was deposited because gradients in river channels were lower, filling and choking channels. As early as 1867, tailings from placer mines had accumulated to as much as 70-ft thick in the Bear River drainage and had created major problems with flooding of downstream cities and navigation on the Feather and Sacramento rivers (Averill, 1946). After the Sawyer Decision in 1884 (issued by Judge Lorenzo Sawyer against the North Bloomfield Mining Company) hydraulic mining nearly ceased. The Caminetti Act, passed by the U.S. Congress in 1893, allowed mines to operate only if mine operators built approved debris dams.

The Bear River is one of the most environmentally impacted rivers in the Sierra Nevada with more than 254 million yd$^3$ of gravel and sediment added from hydraulic mining, second only to the much larger Yuba River watershed (Gilbert, 1917). It was estimated that by 1881, more than 105 million yd$^3$ of gravel had been washed from the mines in the Dutch Flat mining district (U.S Congress, 1881). This figure does not include the deeper gravels washed through the tunnels that were active during the 1880s and 1890s. Drift mining along the gravel–bedrock contact continued after cessation of hydraulic mining with an estimated 30 million yd$^3$ having been mined in the Dutch Flat district by this method.

We estimate for the period of 1884 through 1901 that more than 50 million yd$^3$ washed through tunnels in the Dutch Flat district. These sediments entered the Bear River behind a log crib debris dam (since removed, except for bedrock foundation). This dam, jointly used by the Elmore Hill, Nary Red, Polar Star, and Southern Cross mines in Placer County and the Liberty Hill mine in Nevada County, was inundated with debris and sediment that was eventually released down the Bear River when it breached. Much of the coarser material remains along the shoreline and in local ravines whereas finer grained sediments fill wide low-flow sections of the river.

Recent studies (James, 1991) indicate that more than 139 million yd$^3$ of hydraulic tailings remain stored in the lower Bear River Basin. The sediments released during placer mining in the upper Bear River basin are extensive and their volume is unknown. These sediments are subject to sustained remobilization (James, 1991) which is in contrast with Gilbert's (1917) symmetrical wave model of sediment transport that implied a rapid return of sediment loads to pre-hydraulic mining levels. Recent floods (December 1996 through January 1997) remobilized large quantities of hydraulic mine tailings and sediment in the drainages of the basin, exposing elemental mercury in the stream bed.

## MERCURY TRANSPORT AND BIOACCUMULATION

Previous work has documented mercury concentrations as high as 0.33 µg/g (micrograms per gram) in fish tissue (Slotton and others, 1997) and 0.37 µg/g in sediment (Domagalski, 1998) from the Bear River watershed. These compare with background values in uncontaminated areas of less than 0.1 µg/g in fish tissue and 0.06 µg/g in sediments (Porcella and others, 1995; Hornberger and others, 1999). On a watershed scale, we have demonstrated a correlation between mercury bioaccumulation data (Larry Walker Associates, 1997) and volume of gravel hydraulically mined (Gilbert, 1917) (fig. 5). The highest values of bioavailable mercury are found in watersheds that are the most environmentally impacted from hydraulic placer-gold mining.

Previous studies have estimated that substantial amounts of mercury, between 3,300 tons (California Regional Water Quality Control Board–Central Valley Region, 1987) and 10,000 tons (Hornberger and others, 1999), were transported along with remobilized sediment from hydraulic mining to San Francisco Bay. In two San Pablo Bay cores, the isotopic compositions of sediment deposited between 1850 and 1880 (Jaffe and others, 1998) correlate with those found in exposed Tertiary-age gravels at abandoned hydraulic gold mines in the Bear River watershed (Bouse and others, 1996). Mercury concentrations in these core

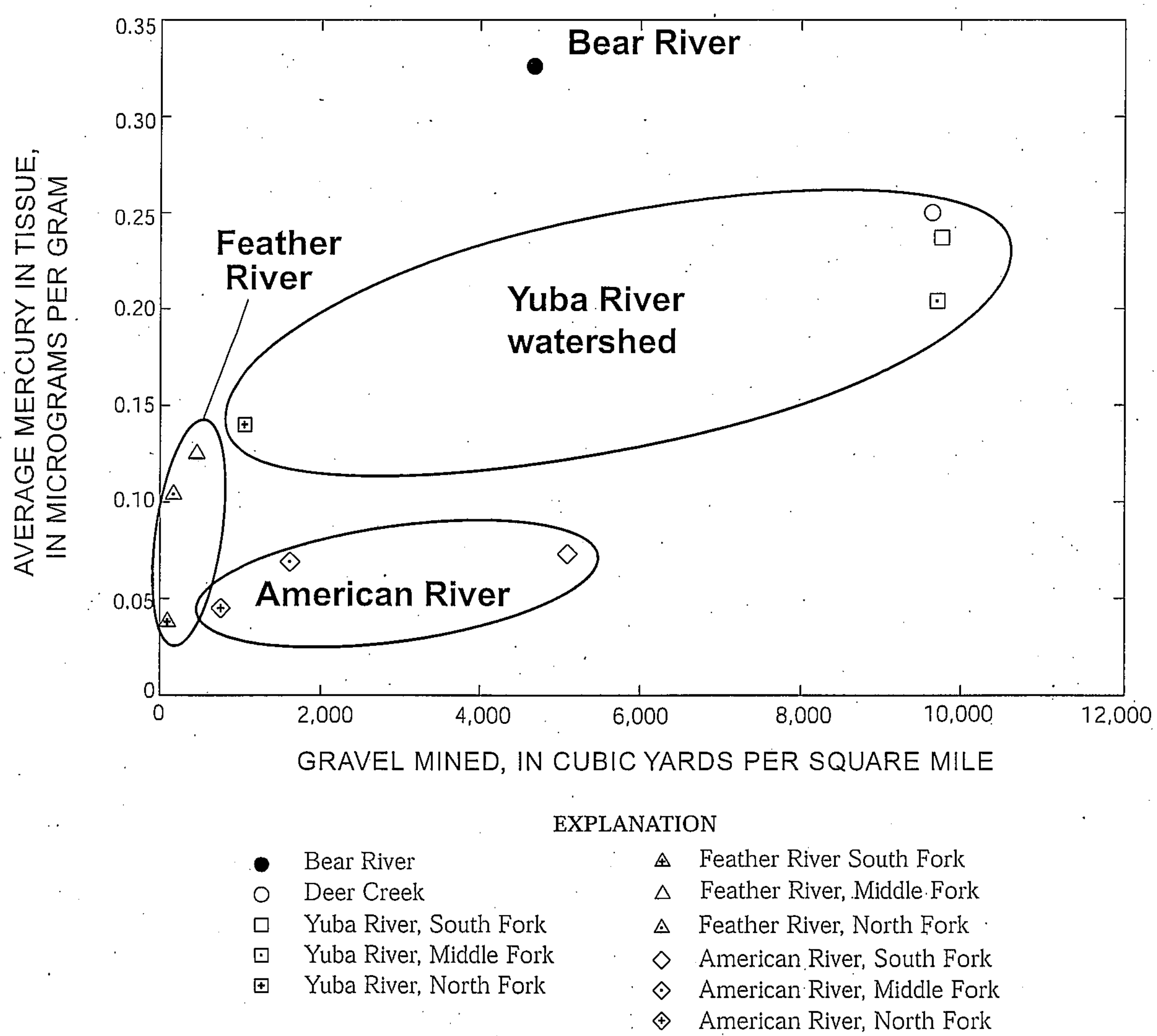


**Figure 5.** Correlation of yardage mined (normalized to area of drainage basin, in square miles) with average tissue mercury concentration, normalized to an intermediate trophic level (mercury data from Larry Walker Associates, 1997).

sediments range from 0.3 μg/g to 0.5 μg/g. Mercury concentrations as high as 1.2 μg/g have been found in core sediment from Grizzly Bay (Hornberger and others, 1999).

## METHODS

Mine drainage waters and sediment were sampled from a historic intact sluice box at an abandoned mine in the Dutch Flat mining district (mine #1) during July and August 1998 and from the portal of another (mine #2) during August 1998. Waters flowing from the portals of these mines were sampled for total and methyl mercury using precleaned bottles provided by Frontier Geosciences Inc. Samples were filtered using an ultraclean 0.45 μm (micrometer) nitrocellulose membrane. Wet gravity separation (that is, panning) was used in the field with a portable balance to estimate the mercury concentrations in the sluice box sediments. Random 1-kg (kilogram) grab samples were weighed, sieved to less than 0.25 in., and panned to separate total recoverable elemental mercury. The mercury was weighed and compared with the initial sample for a gram per kilogram ratio (g/kg). Grab samples were carefully taken from undisturbed top sediments and a specially designed suction tube was used to recover deep sediments at the bedrock contact. Fish collection was done by electrofishing a quarter-mile reach of the Dutch Flat Afterbay (fig. 3). Trout collected from the Dutch Flat Afterbay by USGS personnel were analyzed for total mercury in fillets by the California Department of Fish and Game's laboratory in Moss Landing, California.

## RESULTS

Field reconnaissance identified numerous drainage tunnels, bedrock cuts, and ground-sluice remains, all of which contain visible mercury in the Dutch Flat district. In one drainage tunnel an original intact sluice box was identified. Initial results using pan concentration and a portable scale showed as much as 30 g (grams) of elemental mercury from 1 kg of carefully selected sluice-box sediment.

### Mercury in mine-drainage waters

Total mercury concentrations in four water samples from mine #1 ranged from 45 to 10,400 ng/L (nanograms per liter) in unfiltered water samples and from 7 to 225 ng/L in filtered water samples. Methyl mercury concentrations ranged from 0.01 to 1.0 ng/L in unfiltered samples. A single sample from mine #2 had 44.7 ng/L unfiltered and 7.4 ng/L filtered total mercury. Unfiltered methyl mercury was 0.01 ng/L in the single sample from mine #2. Limited monitoring data for mine-drainage flows from mine #1 measured with a Parshall measuring flume in April and May 1998 indicated discharge in excess of 50 gallons per minute (R. Humphreys, California State Water Resources Control Board, written commun., 1998)

### Mercury in sluice box sediment

Total mercury in sediment samples collected from a sluice box in the Dutch Flat mining district ranged from 1,800 to 15,000 ng/g (nanograms per gram) wet basis, and from 2,400 to 21,000 ng/g dry basis. Methyl mercury in sediment ranged from 0.1 to 0.2 ng/g wet basis, and from 0.2 to 0.3 ng/g dry basis. A sample of white clay precipitate and fine sand from another processing site in the district had 4,270 ng/g wet and 6,710 ng/g dry weight total mercury. Methyl mercury was 0.003 ng/g wet weight and 0.005 ng/g dry weight. Total mercury recovered from panning of sluice box sediment ranged from 0.6 to 26 g/kg. Total mercury concentrations of 0.6, 0.9, and 1.0 g/kg were recovered from top gravels. Total mercury values for the bottom gravels were 16, 18, and 26 g/kg, indicating that the elemental mercury is strongly concentrated near the bedrock contact.

On the basis of observations in the Dutch Flat mining district, a preliminary estimate was made of total mercury in sluice-box sediments. A typical sluice-box has a cross sectional area of 15 $ft^2$ (5 ft wide and 3 ft high). Assuming that bottom gravels represent about 10 percent of the total sluice-box sediment, and using mercury concentrations for bottom and top sediments determined by panning, each linear foot of sluice box is estimated to contain 3 to 5 lb of mercury. This estimate pertains only to sluice boxes that remain full of sediment.

Ground and tunnel sluice boxes range in length from tens to thousands of feet. Therefore, sluice boxes are likely to contain hundreds to thousands of pounds of mercury in their present condition.

### Mercury in fish tissue

The fish collected for mercury analyses were five adult rainbow trout (*Salmo gairdneri)*. Total mercury in the fish tissue ranged from 0.1 to 0.2 µg/g (micrograms per gram) on a dry weight basis, or 0.03 to 0.05 µg/g on a wet weight basis.

## DISCUSSION

Previous studies identified elevated levels of mercury in the aquatic food web of the Bear River watershed (Larry Walker Associates, 1997), however, identification of point source(s) were lacking. The mercury bioaccumulation problem is pervasive and regional throughout Sierra Nevada streams that are tributary to the Sacramento River, the Sacramento–San Joaquin Delta, and San Francisco Bay (fig. 4). This study has shown a relationship between the intensity of hydraulic gold-mining and degree of mercury bioaccumulation on a watershed scale (Fig. 5). Since the cessation of hydraulic mining, accumulated sediment from hydraulic placer mining has been transported to Sacramento–San Joaquin Delta and San Francisco Bay by sustained remobilization (James,1991). The USGS is working with the Forest Service, the Bureau of Land Management, and the Nevada County Resource Conservation District to develop plans to address mercury occurrence, fate, and transport in the Bear River and South Fork Yuba River watersheds, the areas of the Sierra Nevada that apparently are most environmentally impacted by hydraulic mining (fig. 5).

The extremely high mercury concentrations found in this study in water and sediment suggest that hydraulic placer-gold-mining sluices and drainage tunnels may be important contributors of mercury to the downstream Bay-Delta system and that remobilization of mercury is occurring at specific hot spots on a seasonal basis. Two important conclusions of this paper are that localized point sources of mercury likely exist throughout the entire hydraulic gold mining region, and that methylation of mercury is occuring close to the sources, allowing methyl mercury to enter the food web. These point sources offer the most treatable target areas for investigation of possible remediation projects.

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## AUTHOR INFORMATION

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James J. Rytuba, U.S. Geological Survey, Menlo Park, California

# Exhibit 3

## Alison Harvey

**From:** Russell Towle [rtowle@inreach.com]
**Sent:** Tuesday, May 08, 2007 4:55 PM
**To:** Alison Harvey
**Subject:** Re: Mercury in the North Fork

On May 8, 2007, at 3:57 PM, Alison Harvey wrote:

> Hi Russell,
>
>
>
> I wonder if you have any data on the amount of mercury used in the
> historic hydraulic mining activities that fed into tributaries of the
> North Fork.

Hi Alison,

There was a large amount of mercury used in hydraulic mining, and also in hard-rock mining, especially in the early days, when one crushed up the ore--quartz veins with some gold--in a stamp mill, and then ran the crushed ore through a sluice box, charged with mercury of course.

People often ignore the hard rock mines re mercury, because the volume of material worked through the sluice boxes was miniscule compared to hydraulic mining. Nevertheless, it may be regarded as certain that Wolf Creek, near Grass Valley, is contaminated with mercury solely as a result of hard rock mining. For more perspective on hard rock mining and mercury, research the Virginia City mines, which contaminated, what, the Carson River, with mercury? Some astounding amount of mercury is supposed to be down in the Carson now? There was a study done within the past ten years I think.

So far as hydraulic mines, one rough rule of thumb is that a single thousand-foot sluice box would be charged with one ton of mercury. In order to make up for inevitable loss of the mercury out the lower end of the sluice box, a hundred-pound flask would be added every day.

So, suppose there are "ten" claims at any one time working in the Gold Run Diggings, tailing into Canyon Creek and Indiana Ravine and thence to the North Fork. Each claim has, let's say, a "thousand-"foot" sluice box. Each sluice box loses one hundred pounds of mercury per day. Thus the ten claims together lose a thousand pounds per day.
The mining season ran from November through May, roughly. Then the water ran out. So we have, Nov, Dec, Jan, Feb, Mar, Apr, May. Seven months, call it 200 days of mining, and a thousand pounds of mercury running into the North Fork each day. Hence 200,000 pounds per year.
Which equals one hundred tons per year.

But the Gold Run mines were not the only mines tailing into the North Fork. Iowa Hill, Lost Camp, Blue Bluffs, and Humbug Canyon mines all tailed into the North Fork.

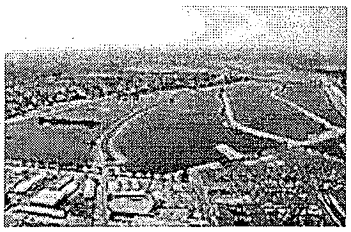
The Bear River received probably even larger amounts of mercury, with the mines of Red Dog, You Bet, Little York, Christmas Hill, Lowell Hill, Liberty Hill, Dutch Flat and Elmore Hill all tailing into the Bear.

Various gravel plants mine the tailings in the Bear for general road base rock etc. So far as I know they all run the tailings through sluice boxes while processing, and recover some amount of gold, which they do not like to talk about. Still less do they like to talk about how much mercury they recover.

You might want to talk with Mike Hunerlach at the USGS, his office is in Sacramento.

Hope this helps,

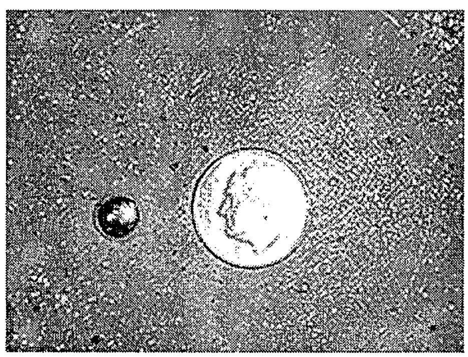
# Exhibit 4





# Mecury

Mercury is a rare, dense metal, slightly more common than gold in the earth's crust. It has unusual properties that have made it valuable in metallurgy, electrical systems and chemical processes. It is a liquid at ordinary temperatures and evaporates when exposed to the atmosphere. These unusual physical characteristics, combined with mercury's common use from the beginning of the industrial revolution, have contributed to its widespread dispersion through the atmosphere to land and water around the globe by both wet and dry precipitation. The US EPA estimates that mercury vapor residence time in the atmosphere exceeds one year.



**Elemental mercury from the bottom of Peoples Creek**

Mercury has been recognized as a serious environmental contaminant for many years. As a result, industrial uses have declined significantly over recent decades as effective substitutes have been developed. The US EPA estimates that in the United States the single largest remaining source of mercury discharges into the environment is coal combustion.

Mercury concentrations in coal are generally less than one part per million (ppm), but, in the United States alone, the large tonnage of coal consumed introduced an estimated 50 tons of mercury into the atmosphere in 1995.

Environmental mercury contamination concerns in California are focused less on atmospheric sources, and more on aquatic sources for several natural and historic reasons.

Mercury's discovery in California predates the discovery of gold by several years. The first mines were located in New Almaden, about 10 miles south of present-day San Jose in the Santa Cruz Mountains. The site is now the Almaden Quicksilver County Park, Santa Clara County. The California Coast Ranges went on to be among the most productive mercury districts in the world, with

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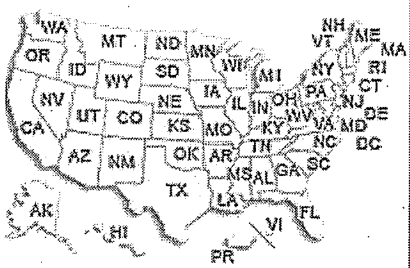
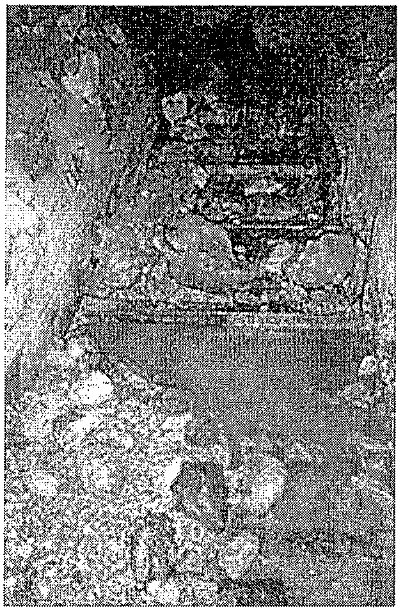



major production centers from New Idria in the south to Clear Lake in the north.

In the Coast Ranges, mercury has been concentrated extensively in natural hydrothermal systems, including active thermal springs that continue to discharge into streams and lakes, and in fossil (inactive) systems that were the sites of commercial mercury mining. The hydrothermal activity contributes to high natural background levels of mercury in parts of the Coast Ranges. The discovery of commercial mercury ore bodies led to the development and operation of numerous mines from the 1840s to the early 1960s, from which more than 220,000,000 pounds of elemental mercury were produced. There were few controls on the dispersion of mercury from these operations, leading to significant increases in environmental mercury concentrations in affected soil, sediment, plants, fish, and other animals. Health advisories on fish consumption because of elevated mercury concentrations are widespread in the Coast Ranges, where 13 separate water bodies are affected, including San Francisco Bay, Lake Berryessa, and Clear Lake.

The 1848 discovery of gold in the Sierra Nevada created a ready market for mercury produced by the mines in California's Coast Ranges. Mercury forms a relatively insoluble amalgam with gold, and miners used this property to increase gold recovery. Millions of pounds of mercury were used, especially in hydraulic placer mining operations that displaced and processed more than 1.5 billion cubic yards of gold-bearing sediments in the Sierra Nevada. Gold- bearing sediments were washed through sluice boxes over mercury that was loosely held in riffles and troughs. Coarse gold was trapped primarily by gravity separation, while the recovery of fine-grained gold was achieved largely with mercury. An estimated 10 to 30 percent of the mercury was lost to the environment in this process, transported into streams and reservoirs along with the discharged sediments (tailings or ?slickens?) from the hydraulic mining operations.

In many gold-mining areas where mercury was used, it is still relatively easy to find quantities of liquid elemental mercury in sediments and stream channels. Of even greater environmental concern is the presence of methylmercury, an organic form of mercury that is a potent neurotoxin and is especially detrimental to developing fetuses and young children (less than about 6 years old). Methylmercury accumulates and biomagnifies in the food chain, reaching highest concentrations in predatory fish,



**Tunnel sluice with mercury-contaminated sediments**

many of which are prized by sports fishermen. At this time, there are no fish consumption advisories for mercury in California's gold mining areas, including the Sierra Nevada and the Trinity-Klamath Mountains.

Mercury from hydraulic mining has been transported with sediments downstream into the San Francisco Bay/Sacramento-San Joaquin Delta estuary, where it has likely contributed to elevated mercury concentrations in fish, resulting in consumption advisories. Ongoing studies will attempt to determine the present sources of mercury and methylmercury to the Bay-Delta, including continuing runoff from mercury mining areas in the Coast Ranges, from gold-mining areas in the Sierra Nevada, and from resuspension and diffusive transport from mercury-contaminated sediments already in the river and Bay-Delta systems.

**Links to: Bear-Yuba, Dutch Flat, and Trinity River Watersheds**



U.S. Department of the Interior | U.S. Geological Survey
URL: http:// ca.water.usgs.gov /mercury/index.html
Page Contact Information: GS-W-CAdist WWW
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# Exhibit 5

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

# NEWS RELEASE

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

**FOR IMMEDIATE RELEASE:**
**Release No. 04-06**
**September 2, 2004**

**CONTACT: Allan Hirsch**
**(916) 324-0955**
**www.oehha.ca.gov**

## OEHHA Finalizes Advisory on Mercury in Fish in Lake Natoma and the Lower American River

SACRAMENTO -- The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) has finalized a fish advisory concerning elevated levels of mercury in fish from Lake Natoma and the lower American River in Sacramento County.

"Fish are still recommended as part of a healthy, balanced diet. But anglers and their families – especially women of childbearing age and children – should be aware of the presence of mercury in fish from Lake Natoma and the lower American River, and follow our guidelines for safe consumption of these fish," OEHHA Director Dr. Joan Denton said.

A report containing the advisory and OEHHA's evaluation of potential health threats posed by mercury in the fish is available for viewing and downloading on OEHHA's Web site at www.oehha.ca.gov.

The advisory contains guidelines for consumption of bass, channel catfish and other fish species from Lake Natoma, the lower American River between Nimbus Dam and Discovery Park, and nearby creeks and ponds. One set of proposals is for women of childbearing age and children age 17 and younger, who are particularly sensitive to methylmercury (the most prevalent and toxic form of mercury in fish). A second set of proposals is for women beyond their childbearing years and men.

The guidelines call for women of childbearing age and children age 17 and younger to refrain from eating all channel catfish from these water bodies; while limiting consumption of all bass, white catfish, pikeminnow, and sucker to one meal a month; and bluegill, sunfish and other species to one meal a week.

The guidelines also call for women beyond childbearing years and men to limit their consumption of channel catfish and bass from these water bodies to one meal a month; white catfish, pikeminnow and sucker to one meal a week; and bluegill, sunfish and other species to three meals a week.

OEHHA's evaluation and advisory are based on mercury analyses of fish samples from these water bodies by the U.S. Geological Survey, the University of California, Davis, and state and local monitoring programs.

Mercury in fish from these water bodies originated from gold-mining and dredging activity that took place from the Gold Rush until the 1950s. Miners used inorganic mercury to extract gold from mined materials and discharged the waste into rivers and streams, where mercury accumulated in the sediment. Bacteria converted the inorganic mercury to the more toxic methylmercury, which fish take in from their diet. Methylmercury can accumulate in fish to concentrations many thousands of times greater than mercury levels in the surrounding water.

Women can pass methylmercury on to their fetuses through the placenta, and to infants through breast milk. Excessive exposure to methylmercury may affect the nervous system in children, leading to subtle decreases in learning ability, language skills, attention and/or memory. These effects may occur through adolescence as the nervous system continues to develop. In adults, the most subtle symptoms clearly associated with methylmercury toxicity are numbness or tingling sensations in the hands and feet or around the mouth. Other symptoms at higher levels of exposure could include loss of coordination and vision problems.

The new advisory contains the same consumption guidelines as an earlier draft advisory that OEHHA released for public review and comment in April 2004.

*The Office of Environmental Health Hazard Assessment is one of six entities within the California Environmental Protection Agency. OEHHA's mission is to protect and enhance public health and the environment by objective scientific evaluation of risks posed by hazardous substances.*

oOo

# HEALTH ADVISORY

**Fish are nutritious, providing a good source of protein and other nutrients, and are recommended as part of a healthy, balanced diet. As with many other kinds of food, however, it is prudent to consume fish in moderation and to make informed choices about which fish are safe to eat. OEHHA provides this consumption advice to the public so that people can continue to eat fish without putting their health at risk.**

| **LAKE NATOMA (including nearby creeks and ponds) AND THE LOWER AMERICAN RIVER*** FISH CONSUMPTION GUIDELINES | |
|---|---|
| WOMEN OF CHILDBEARING AGE AND CHILDREN AGED 17 YEARS AND YOUNGER EAT NO MORE THAN: | |
| DO NOT EAT | CHANNEL CATFISH |
| ONCE A MONTH | White catfish; all bass; pikeminnow; *or* sucker *OR* |
| ONCE A WEEK | Bluegill; sunfish; or other sport fish species |
| WOMEN BEYOND CHILDBEARING AGE AND MEN EAT NO MORE THAN: | |
| ONCE A MONTH | Channel Catfish or all bass *OR* |
| ONCE A WEEK | White catfish; pikeminnow; or sucker *OR* |
| 3 TIMES A WEEK | Bluegill; sunfish; or other sport fish species |

***MANY OTHER WATER BODIES ARE KNOWN OR SUSPECTED TO HAVE ELEVATED MERCURY LEVELS.** If guidelines are not already in place for the water body where you fish, women of childbearing age and children aged 17 and younger should eat no more than one sport fish meal per week and women beyond childbearing age and men should eat no more than three sport fish meals per week **from any location.**

**EAT SMALLER FISH OF LEGAL SIZE.** Fish accumulate mercury as they grow.

**DO NOT COMBINE FISH CONSUMPTION ADVICE.** If you eat multiple species or catch fish from other water bodies, the recommended guidelines for different species and locations should not be combined. For example, if you eat a meal of fish from the one meal per month category, you should not eat another fish species containing mercury for at least one month.

**SERVE SMALLER MEALS TO CHILDREN. MEAL SIZE IS ASSUMED TO BE EIGHT OUNCES FOR A 160-POUND ADULT.** If you weigh more or less than 160 pounds, add or subtract 1 oz to your meal size, respectively, for each 20 pound difference in body weight.

CONSIDER YOUR TOTAL FISH CONSUMPTION. **Fish from many sources (including stores and restaurants) can contain elevated levels of mercury and other contaminants. If you eat fish with lower contaminant levels (including commercial fish) you can safely eat more fish. The American Heart Association recommends that healthy adults eat at least two servings of fish per week. Shrimp, king crab, scallops, farmed catfish, wild salmon, oysters, tilapia, flounder, and sole generally contain some of the lowest mercury levels.**

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## News Release

**U.S. Department of the Interior**
**U.S. Geological Survey**

**Address:**
Office of Communication
119 National Center
Reston, VA 20192

**Release**
September 26, 2000

**Contact**
Dale Alan Cox

**Phone**
916-997-4209

# Mercury from Gold Rush Found in Fish

In a report released today, the U.S. Geological Survey (USGS) has documented elevated levels of mercury in bass and catfish in the Bear and South Yuba River watersheds in the Sierra Nevada of northern California. Mercury is a well-known environmental pollutant that can have serious effects on human health.

"Liquid elemental mercury, or quicksilver, was used extensively in the Bear and Yuba River watersheds since the early gold mining days," said Charlie Alpers, USGS Research Chemist, the study's chief scientist. "Our fish survey is part of the first comprehensive investigation in the Sierra Nevada region of mercury distribution in water, sediment, and biota, and the potential risks to human health and ecosystems."

The USGS report contains data on 141 samples of fish collected during September and October 1999 from reservoirs and stream environments in Nevada, Placer, and Yuba counties. The five reservoirs sampled were Englebright Lake, Scotts Flat Reservoir, Rollins Lake, Lake Combie, and Camp Far West Reservoir. The main target species in these reservoirs was largemouth bass - other species that were sampled included smallmouth and spotted bass, channel catfish, crappie, green sunfish, and bluegill. Brown trout and rainbow trout were sampled predominantly from 17 stream sites, although a small number of trout were also taken from some of the reservoirs.

Mercury concentrations in bass ranged from 0.20 to 1.5 parts per million (ppm), wet basis. Mercury concentrations in sunfish ranged from less than 0.10 to 0.41 ppm. Channel catfish had mercury concentrations from 0.16 to 0.75 ppm. The range of mercury concentrations observed in rainbow trout was from 0.06 to 0.38 ppm, and in brown trout was from 0.02 to 0.43 ppm. For reference, the Food and Drug Administration action level for commercial fish is 1.0 ppm and the State of California considers mercury levels above 0.3 ppm indicative of the need for further study.

"Elemental mercury, the kind you can see, is only one part of the problem," said Jason May, USGS Biologist. "It is the presence of methylmercury, the organic form of mercury that accumulates in organisms, that will be of most concern."

Methylmercury is a potent neurotoxin that is known to be especially detrimental to developing fetuses and young children. Methylmercury is known to biomagnify, or increase in concentration, as it moves up the food chain. Concentrations tend to be highest in predatory fish - those that eat other fish. Some examples of predatory fish are bass and brown trout. The predominant form of mercury in edible fish tissue is methylmercury.

The USGS has submitted its data to the California Environmental Protection Agency and their Office of Environmental Health Hazard Assessment (OEHHA). Environmental health officials from Nevada, Placer, and Yuba counties will be working closely with OEHHA toxicologists to determine whether formal notification to the public will be made concerning potential risks from fish consumption in these areas. According to OEHHA, a total of 12 water bodies in California - including San Francisco Bay, Clear Lake, and Lake Berryessa - have fish consumption advisories related to elevated mercury levels. Some of the mercury levels reported by USGS are in a similar range compared with fish from other water bodies in California for which there are consumption advisories. At this time, there are no fish consumption advisories for mercury in California's historic gold mining areas, including the Sierra Nevada and the Trinity-Klamath Mountains. For more information on the human health perspective contact Allan Hirsch of OEHHA, (916-445-6903).

The USGS fish data report is available at URL: http://ca.water.usgs.gov/mercury/bear-yuba/ . The full title is: "Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California, 1999," by Jason T. May, Roger L. Hothem, Charles N. Alpers, and Matthew A. Law, U.S. Geological Survey Open-File Report 00-367. For more information on the USGS fish study, contact Jason May (916-278-3079; e-mail: jasonmay@usgs.gov), Roger Hothem (530-752-4605; e-mail: roger_hothem@usgs.gov) or Charlie Alpers (916-278-3134; e-mail: cnalpers@usgs.gov).

Federal, state, and local agencies that are funding the USGS investigation include the Bureau of Land Management, the U.S. Department of Agriculture - Forest Service, the California State Water Resources Control Board, and the Nevada County Resource Conservation District. Other organizations cooperating in the effort by providing in-kind services and access to lands include the U.S. Environmental Protection Agency, the California Department of Parks and Recreation, and the Nevada Irrigation District.

The above report is available from the U.S. Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, MS 517, Denver Federal Center, Denver, CO 80225. When ordering, please mention the number and complete title of the report. Payment (check, money order, purchase order, Visa or MasterCard information, including expiration date and signature) in the exact amount, plus a $5.00 handling fee, must accompany order. Make all drafts payable to U.S. Geological Survey, Department of Interior.

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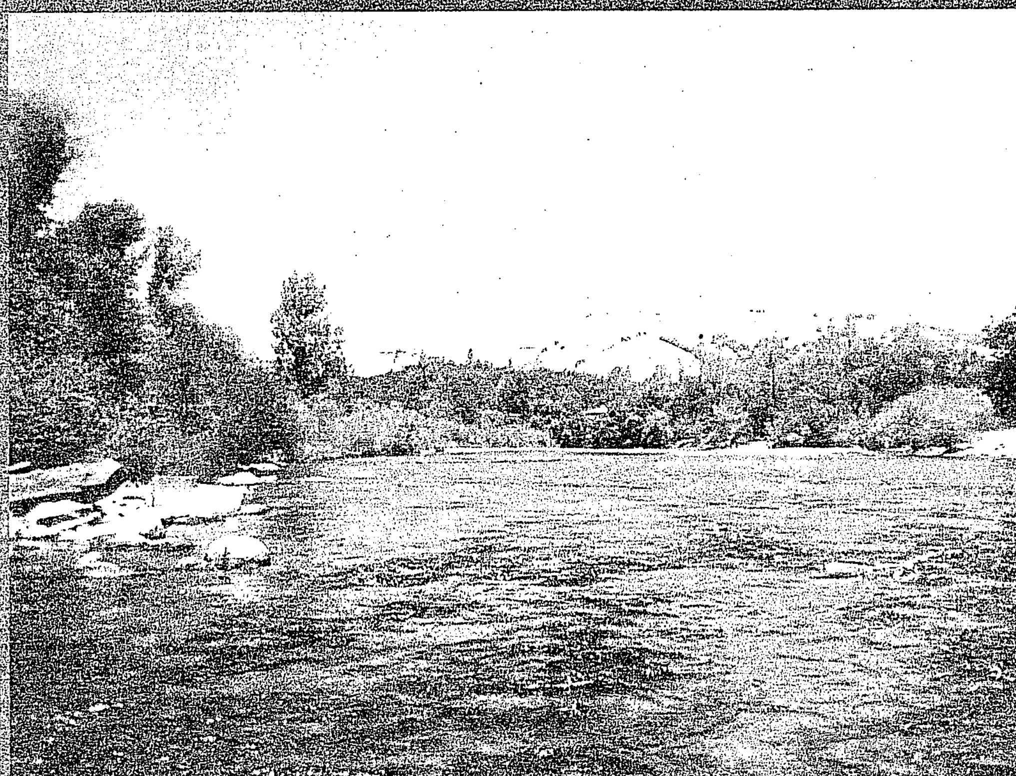
# Exhibit 6

# MERCURY

## LOSSES AND RECOVERY



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Water Boards
STATE WATER RESOURCES CONTROL BOARD
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MAY 2005

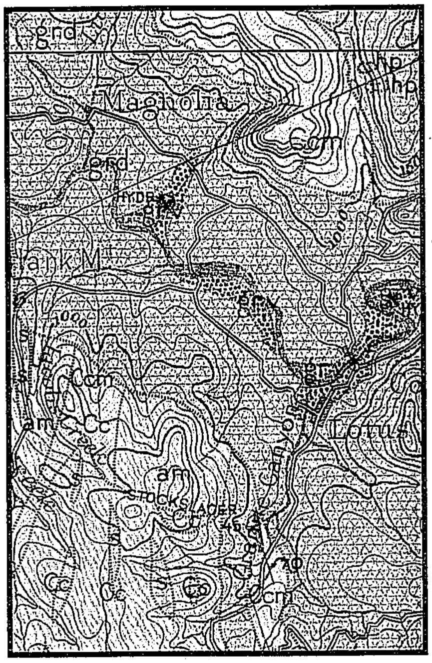


*FIGURE 1: Historical Map of Coloma, California by Waldemar Lindren (1894), United States Geological Survey Folio#3 - Placerville, California, Economic Geology - northwest (Courtesy of: Craig Couch)*

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# ABOUT A KILOGRAM OF MERCURY

## INTRODUCTION

Mercury has been used widely since the dawn of recorded history for gold mining. During California's gold rush, gold miners used about 6 million kilograms or 6.6 thousand tons of mercury (Churchill, 2000) to recover over 3.6 thousand tons of gold (Bulletin 193). **The weight of mercury used is roughly equal to the total weight of a 9-mile long line of 2,750, full sized pickup trucks (note: the pick up truck line equaling gold recovered would only be 5 miles long). The miners lost about half of the mercury to the environment.**

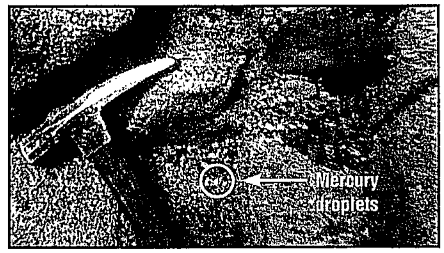


*FIGURE 3: Under water photograph showing river sediment, bedrock, and mercury droplets. (Photo by: Rick Humphreys, DWQ)*

Using historical records, Churchill (2000) estimated that total mercury losses ranged between 2.3 million and 2.6 million kilograms for placer and lode mining in the Sierra Nevada Geomorphic Province. Consequently, elemental mercury from the gold rush is still found, sometimes in amounts that constitute a local hotspot (i.e., a location where visible elemental mercury is found) in Sierra Nevada watersheds where gold mining occurred. In March 2003, a recreational gold miner reported a mercury hotspot in the South Fork of the American River near Coloma, to State Water Resources Control Board staff. It was the first time a recreational gold miner had revealed a hotspot locations to agency staff. Coloma is California's historic "Gold Discovery" site as James W. Marshall's discovery there in January 1848 initiated the 1849 gold rush. Steve Franklin, the recreational gold miner who reported the hotspot, claimed to have recovered about a kilogram of mercury while gold mining from the hotspot during January and February 2003.



**Finding a hotspot near Coloma raised questions about its potential threat to human health, effects on local fish, and threat to water quality. Moreover, its discovery presented an opportunity to test the notion that recreational gold miners effectively clean up mercury hotspots while suction dredging for gold.** There is no record of any attempts by state or federal agencies to clean up a mercury hotspot in a California river. But State and federal agencies have discussed whether encouraging or even providing support for recreational gold miners to clean up hotspots is viable and wise. The pros are that there is a potentially large, volunteer workforce. The cons are that oversight would be difficult and, up to now, no data supported the notion that suction dredges could recover mercury efficiently.

*FIGURE 2: Steve Franklin and SWRCB staff sampled the hotspot on July 8, 2003, and recovered about 125 grams of mercury in about three hours from the river using simple suction recovery tools. Mercury was visible as droplets ranging from one to ten millimeters on bedrock in the river channel. (Photo by: Rick Humphreys, DWQ)*

Recreational gold dredging on public and private lands is a moderately popular activity in California. The Department of Fish and Game (DFG) issues several thousand permits annually to recreational gold dredgers. Along with gold, recreational dredgers recover iron (nails bolts, etc.), lead (fishing weights, buckshot, and spent bullets) and mercury (elemental mercury, mercury/gold amalgam, and mercury stained gold). Over the past several years, United States Forest Service (USFS), Bureau of Land Management (BLM) and State agency staff have discussed setting up a mercury recovery program for recreational dredgers. Incentives (e.g., cash for mercury, free dredging permits, new areas opened for dredging) were proposed in exchange for mercury turned in by recreational dredgers. Offering such incentives was and remains controversial for a variety of reasons and a mercury recovery program was not started. **Moreover, an important drawback was that the efficiency of a standard suction dredge at recovering mercury was unknown.** Consequently, no one knew if mercury would be lost along with waste sediment from a suction dredge. Clearly, a mercury recovery program that dispersed elemental mercury back into a stream in substantial amounts would be unacceptable. The hotspot presented an opportunity to determine the mercury recovery efficiency of a suction dredge.

Studying the hotspot may also reveal bedrock characteristics and sediment transport conditions that cause hotspots, and the effects that concentrated mercury has on local fish. This report documents the results of a suction dredge test that was completed in September 2003 by State Water Board, USFS, and DFG staff.

## Hotspot Setting

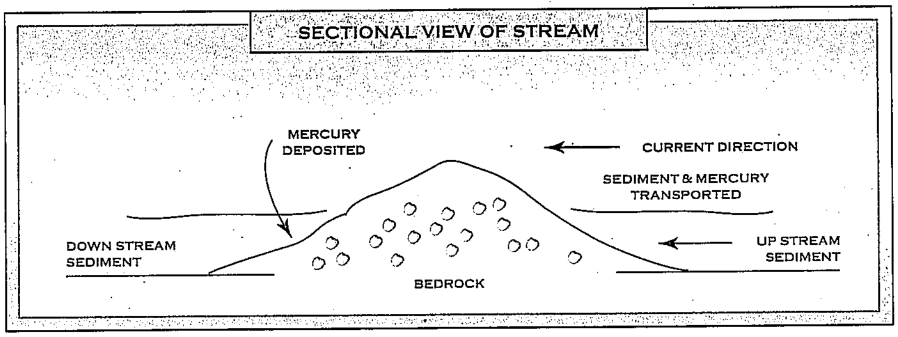


*FIGURE 5: Cross-sectional view of stream graphic showing where mercury deposits on bedrock.*

The hotspot is located mid-channel in the South Fork of the American River, a few miles downstream from the Marshall Gold Discovery State Park at Coloma. Surface placers and in-river gravel accounted for most gold produced from the area during the gold rush and in-river dredging recovered more gold during the 1930s and 1940s (Bulletin 193). These historic mining operations are the likely mercury source.

The hotspot is located on the downstream side of a low bedrock hump that extends across the river channel perpendicular to its flow. Because the hotspot remains underwater under all observed flow conditions, State Water Board skin divers recorded how the mercury occurred on bedrock and in river sediment visually. The bedrock hump is shaped like a low-pitched roof. River sediment forms wedge-shaped deposits on the up and downstream sides of the hump. Easily visible, small (e.g., 1mm) mercury droplets permeate the sediment at the thin upstream edge of the downstream wedge (see fig.2). Hand "fanning" stirs up fine-grained sediment, which is carried away by the river current. Elemental mercury, however, remains on bedrock, and continued fanning causes small mercury droplets to fall into bedrock depressions and fractures. When mercury droplets touch, they fuse into much **large** droplets (up to 25 millimeters). **Hand fanning the upstream sediment wedge also exposes elemental mercury in bedrock depressions and fractures** but in much smaller amounts than on the downstream side.

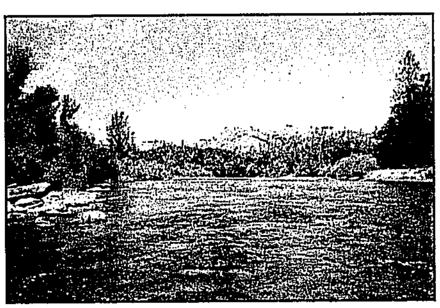

*FIGURE 4: "The hotspot is located mid-channel in the South Fork of the American River, a few miles downstream from the Marshall Gold Discovery State Park at Coloma." (Photo by: Rick Humphreys, DWQ)*

River flow at the hotspot is uncontrolled during winter and spring runoff but controlled for hydroelectric and recreational rafting purposes for the rest of the year. During controlled flow periods, flows typically range from 200 to 1,200 cubic feet per second (cfs) daily. High runoff coincides with winter storms, and these flows have ranged to 80,000 cfs as recently as 1997. Post dredge test inspections show that during low flow periods (200 cfs), sediment does not travel over the bedrock hump. But post dredge test inspections also showed that mercury had re-deposited on bedrock that had been dredged clean. Higher controlled flows may be moving sediment and mercury over the hump but attempts to observe sediment movement directly at higher flows proved too dangerous.

Mercury may concentrate at the hotspot because after it is carried over the bedrock hump during high flows, it encounters a low flow velocity zone on the downstream side of the bedrock hump. The river current on the downstream side lacks the power to move mercury anymore so it drops out on bedrock on the downstream side. If this scenario is correct, **periodic mercury recovery from this location might be practical.** A mercury removal system's design would depend on the site's the physical characteristics which are unknown.. A detailed evaluation of mercury and sediment transport and flow velocity at the hotspot surface would be necessary if periodic mercury removal from this site is considered.

## Suction Dredge Test

The USFS volunteered their mineral evaluation team, based in Redding (Rich Teixeiria, Jim DeMaagd, and Tera Curren), to perform the test. According to Rich Teixeiria, the team's dredge is a Keene Engineering floating 4 inch dredge powered by a Honda 5.5 horsepower engine. It is similar to those used by recreational dredgers to recover gold (see fig.3). A single sluice box used carpet and riffles but no "miners" moss (i.e., woven nylon fabric placed between the riffles and carpet for enhanced gold recovery).

The team performed the dredge efficiency test on Sept.15, 2003. The 63.5kg sediment sample used in the test had been collected by State Water Board staff from the hotspot and characterized for grain size and mercury content. State Water Board staff analyzed the sample's grain size at the Cal Trans Laboratory in Sacramento. The sample classifies as a "clean gravel with sand" under Unified Soil Classification System. Visual inspection of size fractions showed that almost all the liquid mercury rested in the fraction that passed a 30-mesh sieve (0.6mm). The mercury content of this fraction served as a surrogate for the mercury content of the entire sample. Chris Foe of the Central Valley Regional Water Quality Control Board had two 30-mesh passing fractions of the sample analyzed for mercury by ALS Chemex Laboratory in Reno, NV. Two suspended sediment samples of the bulk sample (i.e., samples of sediment that settled out of water used for sieving after

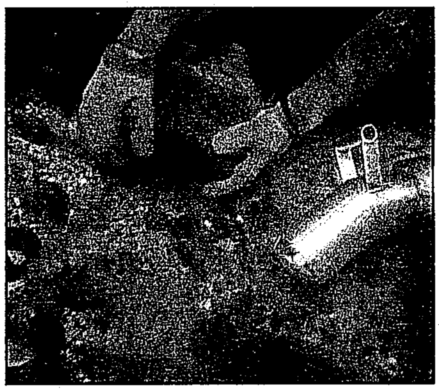

*FIGURE 6. Dredging the hotspot. (Photo by: Rick Humphreys, DWQ)*

an hour) were sent to ALS Chemex Laboratory for mercury analysis. A second set of samples from archived material was sent to Frontier Geosciences in Seattle, WA after reliability problems were discovered with analyses performed on standards by ALS Chemex. During the test, the USFS team captured sediment lost off the sluice in a catch basin for later analysis. Small mercury droplets and fine, barely discernable droplets (i.e., floured mercury) were characteristic of these samples. After the test, 30 mesh and finer dredge concentrates and "waste" sediment were sent to ALS Chemex Laboratory. ALS Chemex Laboratory used an analytical method that could not quantify the high mercury concentration in the mercury-rich samples. So a second set of samples was sent to Frontier Geosciences for analyses.

The team (USFS and State Water Board staff) dredged the hotspot the next day on Sept. 16, 2003, and DFG staff recorded the test on video.

THE MERCURY CONTENT OF THIS FRACTION SERVED AS A SURROGATE FOR THE MERCURY CONTENT OF THE ENTIRE SAMPLE.

## Results - Laboratory Data

ALS Chemex reported that the mercury content of the samples received exceeded the upper detection limit of the analysis used and did not reanalyze the samples. As a result, the Frontier Geosciences analyses were used for this report. The bulk sample mercury concentration was 1,170ppm; the mercury concentration of the sediment captured by the dredge was 1,550ppm, and the mercury concentration of the sediment lost by the dredge was 240ppm. The suspended sediment sample mercury concentration was 298ppm. Note that these mercury concentrations are quite high. **Mercury concentrations of the waste and suspended sediment are over an order of magnitude higher than the minimum concentration necessary for classification as a California hazardous waste (20mg/kg).** The suspended sediment's high mercury content is problematic because after re-suspension by dredging, it can be carried long distances by stream current.

## RESULTS - SUCTION DREDGE EFFICIENCY

It is necessary to know how elemental mercury, which is a dense liquid, behaves physically when evaluating the laboratory results. During dredging, large mercury droplets were broken up into small droplets by turbulence. The phenomenon is called "flouring" and it is described as a major cause of mercury loss by historic hydraulic gold mining operations. Confounding matters is mercury's ability to form large droplets from small droplets. This causes mercury enrichment of sediment captured on the sluice because small mercury droplets that are caught in the low velocity area behind the sluice riffles fuse into large droplets just as they do on the downstream side of the bedrock hump. Sluice sediment samples had large and small mercury droplets. Such samples are subject to analytical bias from either a single large mercury droplet, or the absence of any mercury droplets.

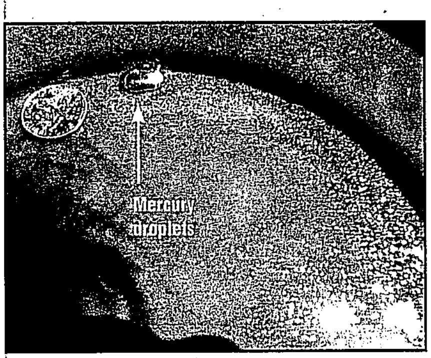


*FIGURE 7: Mercury panned from a small creek below the Sailor Flat Hydraulic Mine, Nevada County. (Photo by: Rick Humphreys, DWQ)*

Bias probably is affecting the analytical results for the efficiency test. The mercury concentration for the captured sediment is 32 percent higher than that of the parent sample, and that may be because the captured sediment sample analyzed had one or two large mercury droplets. However, in absolute terms, the mercury concentration of both samples agrees fairly well. Mercury concentrations in sediment lost by the dredge was averaged (30-mesh and finer and suspended sediment). The mercury concentration of the lost sediment fractions is about 2 percent that of the test sediment's mercury concentration. Thus, the dredge removed about 98 percent of the mercury from the test sample based on concentration. Unfortunately, a mass balance of sediment captured and lost, as part of the test was not performed because we did not have an accurate total mass for the lost fraction.

The test showed that a typical suction dredge set up to recover gold recovered about 98 percent of the mercury in the high-mercury, test sediment sample. However, the loss was in sediment that had high mercury content and is easily transported away by the river.

## RESULTS - IN-RIVER TEST

The team dredged about four yards or about 5,900 kilograms (6.5 tons) of sediment from the hotspot. Team members used special care to find and dredge large liquid mercury droplets as well as mercury-laden sediment from the site. During clean up after the test, team members noted large mercury droplets captured on the sluice. From the 30-mesh passing fraction, SWRCB staff separated about 0.5kg liquid mercury (see fig. 4). The remaining 2.2kg of sediment retained a substantial amount of liquid mercury as small (e.g., 1mm) and fine droplets of floured mercury, which floated on water used to immerse the sediment. Separating residual mercury from the sediment by physical means proved impossible. The mercury content of a 1.1kg sample was determined directly heating the sample and recovering the mercury vapor (i.e., retorting). The retorted sample contained 20gm of mercury or 1.8 percent. The dredge concentrate contained 540gm of mercury (liquid mercury + retorted mercury/ 1.1kg x 2), which accounted for about 20 percent of the sample mass (540gm mercury/2.7kg sieved sample x 100). Note that the mercury concentration of captured sediment from the in river test is about ten times higher than that reported for the efficiency test. The difference likely reflects the success of the dredge team in finding and dredging up mercury droplets during the in river test.

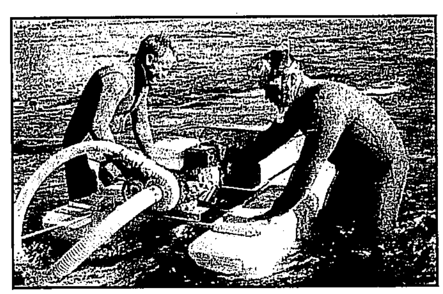

*FIGURE 8: Jim DeMaagd and Rich Teixeiria setting up the dredge. (Photo by: Rick Humphreys, DWQ)*

# Conclusions and Recommendations

1. A suction dredge set up to recover gold recovered liquid mercury from the mercury hotspot. The dredge recovered about 98 percent of the mercury in a test sediment sample enriched in mercury. Mercury concentrations in the fine and suspended sediment lost from the dredge were more than ten times higher than that needed to classify it as a hazardous waste.

2. Lost sediment with high mercury levels is, in effect, mercury recycled to the environment. Floured mercury in fine sediment and mercury attached to clay particles in suspended sediment may be carried by the river to environments where mercury methylation occurs and where fish have high mercury concentrations. The consequences of having floured mercury added to biologically active areas where mercury methylation already occurs are currently unknown because the methylation potential of floured elemental mercury is unknown. But tests are underway at the DFG laboratory at Moss Landing to determine the methylation potential of floured mercury in sediment samples from this hotspot.

3. It is unacceptable to encourage suction dredgers to "clean up" in stream mercury hotspots because dredges release too much mercury in easily transportable forms. There may be other reasons to discourage suction dredging of mercury hotspots once the bioavailablity of floured mercury becomes known. It would be advisable for land management agencies to contact dredgers through their clubs and discourage them from trying to dredge liquid mercury from in-river hotspots on public lands. Removing mercury with hand-operated suction tubes, or better yet, reporting hotspot locations to land management agencies is a better strategy.

4. It might be possible to design a shore-based recovery system for the Coloma hotspot and recover mercury annually. Such a system would need to minimize mercury loss. Recovery equipment would need to be held in storage during nonuse and operated by trained staff. Proper permits (e.g., in stream alteration, and, mercury disposal or recycling) would be needed. Such a project is more complex and costly in time, money, and commitment than previously considered projects. Developing such a system might result in technical advances that could be applied to dredges used by gold dredgers.

5. The sediment transport parameters that cause mercury to concentrate should be characterized. Such a characterization at Coloma might be useful for predicting where other hotspots are located in the South Fork of the American River and other watersheds, and it would provide the data for a recovery project described above.

6. The hotspot's effect on fish and invertebrates in this segment of South Fork of the American River should be determined.

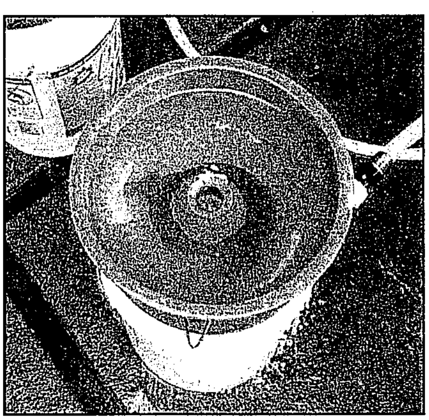

*FIGURE 9. Liquid mercury (about 0.5kg) separated from sediment captured by the dredge. (Photo by: Rick Humphreys, DWQ)*

*FIGURE 10: Under water diver searches for Mercury. (Photo by: Rick Humphreys, DWQ)*

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*Contributions of Mercury to California's Environment from Mercury and Gold Mining Activities - Insights from the Historical Record.* Unpublished report, 18 pages. Ron Churchill, California Geological Survey, Division of Mines and Geology, 2000.

*Gold Districts of California, Bulletin 193, Sesquicentennial Edition.* William B. Clark, 1963 with some revisions through 1969. California Geological Survey, Division of Mines and Geology, 1998.

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## ACKNOWLEDGEMENTS

Special thanks to Steve Franklin for reporting the hotspot and to Bill Center for granting us access to the area and use of his camp at Lotus. Thanks to Janine Clayton (USFS) for making the USFS minerals evaluation crew available. Thanks also to Chris Foe of the Central Valley Regional Water Quality Control Board and Mark Stephenson (DFG) for arranging laboratory analyses, and Chris Foe and Dr. Charles N. Alpers for their reviews. Finally, thanks to dredge crewmembers Rich Teixeiria, Tera Curren, Jim DeMaagd, Dominic Gregorio, and Janna Herren for making the project a success.

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# Exhibit 7

California Department of Fish and Game Final Environmental Impact Report
April 1, 1994
Pages 63 and 64

Discussion on impact on water quality from of resuspension of mercury caused by suction gold dredging

Mercury

The Toxic Substances Monitoring Program of the Water Resources Control Board's Ten Year Summary Report (1978-1987) (TSM Report) shows that mercury contamination of aquatic organisms occurs in many streams in California. The source of the mercury is thought to be 19th Century mining operations. To be taken up by aquatic organisms, the elemental mercury must be methylated. This occurs by anaerobic bacterial processes in streams. Some suction dredgers remove mercury because it may contain gold. To the extent suction dredgers remove mercury from rivers and streams, the effect would be beneficial to the environment. However, the potential exists for mercury to be thrown back into rivers and streams by inexperienced dredgers. Fish and Game Code Section 5650 addresses pollution of this nature. Overall, the Department believes suction dredging with regard to the presence of mercury in California's streams has a less than significant effect on the environment.

Sections on the use of mercury and gold recovery have been omitted from the second DEIR due to public comments noting the outdated nature of the information.

Fish and Game Code Section 5650

5650. (a) Except as provided in subdivision (b), it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this state any of the following:

(1) Any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material or substance.

(2) Any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill, or factory of any kind.

(3) Any sawdust, shavings, slabs, or edgings.

(4) Any factory refuse, lime, or slag.

(5) Any cocculus indicus.

(6) Any substance or material deleterious to fish, plant life, mammals, or bird life.

(b) This section does not apply to a discharge or a release that is expressly authorized pursuant to , and in compliance with, the terms and conditions of a waste discharge requirement pursuant to Section 13263 of the Water **Code** or a waiver issued pursuant to subdivision (a) of Section 13269 of the Water **Code** issued by the State Water Resources Control Board or a regional water quality control board after a public hearing, or that is expressly authorized pursuant to, and in compliance with, the terms conditions of a federal permit for which the State Water Resources Control Board or a regional water quality control board has, after a public hearing, issued a water quality certification pursuant to Section 13160 of the Water **Code**. This section does not confer additional authority on the State Water Resources Control Board, a regional water quality control board, or any other entity.

(c) It shall be an affirmative defense to a violation of this section if the defendant proves, by a preponderance of the evidence, all of the following:

(1) The defendant complied with all applicable state and federal laws and regulations requiring that the discharge or release be reported to a government agency.

(2) The substance or material did not enter the waters of the state or a storm drain that discharges into the waters of the state.

(3) The defendant took reasonable and appropriate measures to effectively mitigate the discharge or release in a timely manner.

(d) The affirmative defense in subdivision (c) does not apply and may not be raised in an action for civil penalties or injunctive relief pursuant to Section 5650.1.

(e) The affirmative defense in subdivision (c) does not apply and may not be raised by any defendant who has on two prior occasions in the preceding five years, in any combination within the same county in which the case is prosecuted, either pleaded nolo contendere, been convicted of a violation of this section, or suffered a judgment for a violation of this section or Section 5650.1. This subdivision shall apply only to cases filed on or after January 1, 1997.

(f) The affirmative defense in subdivision (c) does not apply and may not be raised by the defendant in any case in which a district attorney, city attorney, or Attorney General alleges, and the court finds, that the defendant acted willfully.

# Exhibit 8

*Rana boylii* Baird, 1854(b)

## FOOTHILL YELLOW-LEGGED FROG

*Gary M. Fellers*

**1. Historical versus Current Distribution.** Historically, foothill yellow-legged frogs (*Rana boylii*) ranged throughout much of southwestern Oregon (west of the crest of the Cascade Mountains). The northernmost records are from the Santiam River system in Marion County, Oregon. In California, foothill yellow-legged frogs were found in most of the northwest and south throughout the foothill regions of the coast range (south to the San Gabriel River system, Los Angeles County) and along the western slopes of the Sierra Nevada south to Kern County, and through the Tehachapis and San Gabriel Mountains in southern California. An isolated population has been reported from the Sierra San Pedro Martir of Baja California (Loomis, 1965). A live animal from there was examined and confirmed by R.C. Stebbins, but no specimen exists today (R.C. Stebbins, personal communication). Zweifel (1955) provides a detailed map of the historical range. Foothill yellow-legged frogs range from near sea level to 1,800 m in Oregon (Leonard et al., 1993) and to 1940 m in California (Hemphill, 1952).

Since 1993, my field crews and I have conducted extensive surveys for foothill yellow-legged frogs in California, visiting 804 sites (in 40 counties) that had suitable habitat within the historical range. We found at least one foothill yellow-legged frog at 213 of these sites (26.5% of sites), representing 28 counties.

Extant populations of foothill yellow-legged frogs are not evenly distributed in California. In the Pacific northwest, 40% of the streams support populations of foothill yellow-legged frogs, while that number drops to 30% in the Cascade Mountains (north of the Sierra Nevada), 30% in the south coast range (south of San Francisco), and 12% in the Sierra Nevada foothills.

**2. Historical versus Current Abundance.** While the number of populations is important, population size is also critical. Only 30 of the 213 sites in California with foothill yellow-legged frogs have populations estimated to be 20 or more adult frogs.

The situation for foothill yellow-legged frogs in the Sierra Nevada is bleak; there are no populations in the southern Sierra Nevada foothills that are likely to remain viable for more than a decade. Populations in the northern Sierra are more numerous and generally larger, but they may be in decline as well. Additionally, many of the foothill streams to the northern Sierra Nevada have recreational gold mining activities, which alter the streambed and are likely having a serious, negative impact on the frog fauna.

In the south coast range, several populations of foothill yellow-legged frogs along streams draining into the Central Valley appear to be doing well, in spite of heavy livestock grazing. There are almost certainly other good foothill yellow-legged frog populations in this region, but they are on lands that are privately owned and are thus inaccessible.

The largest populations in California are in the north coast range where the estimated number of adult frogs exceeds 100 at six sites, and an additional nine populations have > 50 adult frogs. The Pacific Northwest is clearly the stronghold for foothill yellow-legged frogs in California, with healthy populations scattered throughout the region.

In Oregon, foothill yellow-legged frogs were once one of the most abundant amphibians in the Rogue River area of southwestern Oregon (Fitch, 1936). Now they are rare or absent throughout the entire western half of their range. There is only one known population in the Cascade foothills on the east side of the Willamette Valley (C. Pearl and D. Olson, personal communications). Farther south, foothill yellow-legged frogs are rare in the Klamath Basin. In the western half of the range, there are moderately good populations in the Umpqua River drainage, and frogs become more common farther south toward California.

**3. Life History Features.**

**A. Breeding.** Reproduction is aquatic. Oviposition behavior was recently described by Wheeler et al., 2003).

i. Breeding migrations. Adult migrations appear to be limited to modest movements along stream corridors (Ashton et al., 1998), but the magnitude of such movements, any seasonal component, and differences between sexes remains largely unknown.

ii. Breeding habitat. Unlike other ranid frogs in California, Oregon, and Washington, foothill yellow-legged frogs mate and lays eggs exclusively in streams and rivers. Males typically vocalize underwater (MacTeague and Northern, 1993), but frogs occasionally call above water (Ashton et al., 1998). Their calls are rarely heard.

Timing and duration of breeding activity vary geographically and across populations, but generally occurs during the spring. In California, we have found egg masses between 22 April–6 July, with an average of 3 May. In some areas such as the Trinity River (Trinity County, California), foothill yellow-legged frogs lay eggs throughout the 3 mo period of April–June (Ashton et al., 1998). Other authors cite shorter periods of breeding, i.e., within a 2-wk window that occurs between late March and May (Storer, 1925; Grinnell et al., 1930; Wright and Wright, 1949; Zweifel, 1955). Kupferberg (1996a,b) reports an approximate breeding period of 1 mo beginning late April to late May. A Marin County, California, population generally lays eggs within a much smaller window of a few weeks around late April. Rainfall during a given breeding season can delay oviposition (Kupferberg, 1996a,b). Lind et al. (1996) found that water releases from a dam on the Trinity River washed away most foothill yellow-legged frog egg masses in the main stream of the river.

**B. Eggs.**

i. Egg deposition sites. Oviposition sites are generally shallow, slow-moving water with a cobble or pebble substrate that is used to anchor each egg mass. On occasion, egg masses may be attached to aquatic vegetation, woody debris, and gravel. Masses are usually attached to the downstream side of rocks, at the stream margin, and at depths of < 0.5 m (Stebbins, 1985; Fuller and Lind, 1992; Ashton et al., 1998).

ii. Clutch size. Egg masses vary in size and in the number of eggs/mass. The size of an egg mass after it has absorbed water (usually a few hours after oviposition) is 5–10 cm in diameter and "resembles a cluster of grapes" (Stebbins, 1985). The number of eggs/mass can range from 300–2,000 (Storer, 1925; Fitch, 1936; Zweifel, 1955), with an average of about 900 eggs (Ashton et al., 1998).

Egg masses observed in the field frequently have silt accumulation on the outer surface (Stebbins, 1985). It is not known if silt accumulation affects egg development, but the silt makes the masses less conspicuous and may reduce predation by visual predators.

Eggs generally hatch within 5–37 d (Zweifel, 1955; Ashton et al., 1998). Hatching rates are influenced by temperature, with faster developmental times in warmer waters, up to the critical thermal maximum temperature of about 26 °C (Zweifel, 1955; Duellman and Trueb, 1986). Tadpoles move away from their egg mass after hatching (Ashton et al., 1998).

**C. Larvae/Metamorphosis.**

i. Length of larval stage. Larval development is, in part, temperature dependent. Typically, tadpoles metamorphose 3–4 mo after hatching.

ii. Larval requirements.

a. Food. Tadpoles feed on algae, diatoms, and detritus by grazing the surface of rocks and vegetation. Diatom rich diets, particularly epiphytic diatoms that contain protein and fat, enhance growth, development, and survival to metamorphosis (Kupferberg, 1996a,b). Tadpoles have also been observed in the field feeding on necrotic tissue of other tadpoles and bivalves (Ashton et al., 1998).

b. Cover. Cover is essential for tadpoles. During the first week of life, tadpoles can often be found within the vicinity of the hatched egg mass. They then move to nearby areas, between and beneath cobble and gravel. When fleeing from threats, their swimming pattern is described as frantic (Ashton et al., 1998).

iii. Larval polymorphisms. None.

iv. Features of metamorphosis. As with most other frog species, major events of metamorphosis include reorganization of the digestive tract, absorption of the tail, and the emergence of front limbs (Duellman and Trueb, 1986). Foothill yellow-legged frogs metamorphose at a size of 1.4–1.7 cm SUL.

v. Post-metamorphic migrations. Young, post-metamorphic frogs tend to migrate upstream from their hatching site (Twitty et al., 1967).

**D. Juvenile Habitat.** Believed to be similar to adults.

**E. Adult Habitat.** Foothill yellow-legged frogs are primarily stream dwelling. Stebbins (1985) describes foothill yellow-legged frogs as stream or river frogs found mostly near water with rocky substrate, as found in riffles, and on open, sunny banks. Other authors have expanded this description, and/or offer variations. Critical habitat (i.e., habitat suitable for egg laying) is defined by Jennings and Hayes (1994a) as a stream with riffles containing cobble-sized (7.5 cm diameter) or larger rocks as substrate, which can be used as egg laying sites. These streams are generally small to mid sized with some shallow, flowing water (Jennings, 1988). Fuller and Lind (1992) observed subadults on partly shaded (20%) pebble/cobble river bars near riffles and pools.

Less typical streams lack a rocky, cobble substrate (Fitch, 1938). Other types of riparian habitats include isolated pools and vegetated backwaters (Hayes and Jennings, 1988). Adult frogs have been observed in deep, shady, spring-fed pools (personal communication).

**F. Home Range Size.** Unknown.

**G. Territories.** Unknown, but other ranid frogs are well known to defend breeding areas (Wells, 1977).

**H. Aestivation/Avoiding Dessication.** Unknown.

**I. Seasonal Migrations.** See "Breeding migrations" above.

**J. Torpor (Hibernation).** None reported.

**K. Interspecific Associations/ Exclusions.** Foothill yellow-legged frogs are frequently found in association with Pacific treefrogs (*Hyla regilla*), western toads (*Bufo boreas*), Sierra garter snakes (*Thamnophis couchi*), and Pacific pond turtles (*Clemmys marmorata*). Less frequent associates include coastal giant salamanders (*Dicamptodon tenebrosus*), California newts (*Taricha torosa*), American bullfrogs (*Rana catesbeiana*), northern red-legged frogs (*Rana a. aurora*), terrestrial garter snakes (*Thamnophis elegans*), and common garter snakes (*T. sirtalis*). There are records of foothill yellow-legged frogs co-occurring with California giant salamanders (*Dicamptodon ensatus*), southern torrent salamanders (*Rhyacotriton variegatus*), rough-skinned newts (*T. granulosa*), tailed frogs (*Ascaphus truei*), and northwestern salamanders (*Ambystoma gracile*; personal observations). Lind et al. (2003) recently found a male foothill yellow-legged frog amplexing a female American bullfrog.

**L. Age/Size at Reproductive Maturity.** It is generally thought that individuals reach reproductive maturity in the second year after metamorphosis (Storer, 1925; Zweifel, 1955); but Jennings (1988) reports that individuals may reproduce as early as 6 mo after metamorphosis. Also, there may be differences by sex. Additional work in this area is needed.

**M. Longevity.** The life span of foothill yellow-legged frogs is not known, and comparisons with the closely related mountain yellow-legged frogs may not be appropriate because these two species live under such different environmental regimes.

**N. Feeding Behavior.** Most of the literature regarding the diet of foothill yellow-legged frogs is rather general in description. Nussbaum et al. (1983) reports that the diet includes flies, moths, hornets, ants, beetles, grasshoppers, water striders, and snails. Terrestrial arthropods (87.5% insects, 12.6% arachnids) were the primary prey items of recently metamorphosed foothill yellow-legged frogs at a single site studied by Van Wagner (1996). Storer (1925) and Fitch (1936) note that terrestrial and aquatic insects are probable food for post-metamorphic frogs.

**O. Predators.** A host of vertebrates and perhaps some aquatic invertebrates feed on foothill yellow-legged frogs. Most species of garter snakes (*Thamnophis* sp.), which co-exist with foothill yellow-legged frogs, prey upon both tadpoles and juvenile frogs. This includes common garter snakes (*T. sirtalis*), terrestrial garter snakes (*T. elegans*), and Sierra garter snakes (*T. couchii*). All but Oregon aquatic garter snakes (*T. atratus hydrophilus*), which prefer tadpoles (Jennings and Hayes, 1994a), are reported to primarily eat young, post-metamorphic individuals (Fitch, 1941; Zweifel, 1955; Lind, 1990).

Several species of amphibians prey upon foothill yellow-legged frogs. Rough-skinned newts (*Taricha granulosa*) eat foothill yellow-legged frog egg masses (Evenden, 1948). Non-indigenous American bullfrogs prey on foothill yellow-legged frogs (Crayon, 1998). Bullfrog larvae apparently do not feed on foothill yellow-legged frogs, but through competitive interactions for algal resources, they can cause a substantial reduction of survivorship and a decreased mass in post-metamorphic individuals (Kupferberg, 1997).

There are no reports of native salmonids preying on foothill yellow-legged frogs, though a variety of introduced trout and warm water fishes eat both the eggs and tadpoles. Green sunfish (*Lepomis cyanellus*, Centrarchidae) are especially pernicious and will systematically eat eggs and larvae (Werschkul and Christensen, 1977). Native Sacramento squawfish (*Ptychocheilus grandis*) feed on adult frogs and eggs (Brown and Moyle, 1997; D. Ashton and R. Nakamoto, personal communication).

**P. Anti-Predator Mechanisms.** None reported.

**Q. Diseases.** None reported.

**R. Parasites.** None reported.

**4. Conservation.** Foothill yellow-legged frogs are susceptible to a wide range of environmental impacts including loss of habitat, pesticides, competition/predation from nonnative species (e.g. warm-water fish, bullfrogs, crayfish), disease, water impoundments, logging, mining, and grazing in riparian zones. In the Sierra Nevada foothills of California, air-borne pesticides (that move east on the prevailing winds blowing across the highly agriculturalized Central Valley) are likely to be the primary threat to foothill yellow-legged frogs (LeNoir et al., 1999; Sparling et al., 2001; Hayes et al., 2002b). It is unknown whether pesticides are contributing to the decline of foothill yellow-legged frogs in Oregon (especially east of the agricultural parts of the Willamette Valley), but it should be examined. The populations of foothill yellow-legged frogs in greatest decline are all downwind of highly impacted (mostly agriculturalized) areas, while the largest, most robust frog populations are along the Pacific coast.

Many nonnative species are likely to be competitors and/or predators of foothill yellow-legged frogs, but few studies have examined the impacts of these nonnatives. Chytrid fungus has been found in foothill yellow-legged frogs, but it is not known what the effect on foothill yellow-legged frogs might be, or even whether the fungus is a native pathogen. In some areas, nonnative American bullfrogs co-occur with foothill yellow-legged frogs and are known to have a negative impact (Kupferberg, 1996b, 1997a), but it is unclear whether this is sufficient to cause population-level declines. The role of other nonnatives needs to be investigated.

There is concern that dams along many river drainages negatively impact foothill yellow-legged frogs. Dams not only interfere with normal dispersal and movements, but also provide refugia for nonnative species that are likely affecting foothill yellow-legged frogs. Unfortunately, there is little research on the role of dams and how they relate to native amphibians.

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# Exhibit 9

**California Department of Fish and Game**

**Biological and Aquatic Resources Assessment of Brushy Creek and the North Fork American River Placer County, California**

September 16, 1998

Key conclusions regarding impacts to
Foothill Yellow Legged Frog from suction gold dredging activities

***(CDFG never acted upon these conclusions)***

Appendix A, Page 6:

"There is some evidence that the egg masses of this species are highly susceptible to suspended particulates, e.g. sediment, however to what extent is unknown (Jennings and Hayes, 1994). Disruption of channel bedload in breeding areas and rearing areas will have an adverse effect upon this species."

"...a modification of the existing season is warranted to allow a majority of the tadpoles to reach sub-adult stage where they would be able to escape any suction dredge activity. This drainage has unique characteristics for both ichthyofauna and herpetofauna, evidenced by strong populations of native minnows and amphibians. The development of more restrictive regulations that would protect these resources is warranted."

## APPENDIX A

September 16, 1998

**Biological and Aquatic Resources Assessment of Brushy Creek and the North Fork American River Placer County, California**

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## INTRODUCTION

The biological and aquatic resources investigation of Brushy Creek, tributary to the North Fork American River and the North Fork American River was undertaken to evaluate the existing conditions for a Special Suction Dredge Permit Application from Mr. Bruce Emerson. These surveys were conducted by myself and Jason Webber, Scientific Aid. This appendix will discuss the biological and aquatic resources in Brushy Creek and the herpetological fauna that was observed in the North Fork American River.

## HABITAT DESCRIPTION

Brushy Creek is a tributary to the North Fork American River in the vicinity of Weimar and Colfax in Placer County. Brushy Creek flows south for 3.5 miles and has a overall gradient of 7%. The stream channel is in a deep, v-shaped canyon dominated by slate bedrock with boulders and cobbles (40%, 30%, and 25% respectively). Gravels are limited to less than 5% of the substrate. The gradient varied from 2 to 4% throughout the surveyed reach. The active channel width varied between 6 and 15 feet.

The stream was dominated by shallow pools (<3.0 feet deep), shallow glides, high gradient riffles, and isolated secondary channel pools. The glides and pools were often less than 1.0 foot in depth. Sedges (*Carex* spp.) and tree roots provide overhanging cover in these habitat types. Large substrate and algae provided a majority of instream cover in all habitat types.

The riparian vegetation was comprised of tree willows (*Salix* spp.), white alder (*Alnus rhombifolia*), buckeye (*Aesculus californica*), blackberry (*Rubus* spp.), California bay (*Umbellularia californica*), redbud (*Cercis occidentalis*), sedges, and wild grape (*Vitis californica*). The riparian canopy cover is 60 to 80% and provides extensive shading except in those areas where the channel broadens out. Upland vegetation was dominated by oaks (*Quercus* spp.), toyon (*Heteromeles arbutifolia*), digger pine (*Pinus sabiniana*), douglas fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*).

The hydrology of Brushy Creek is highly flashy with high winter/spring flows evidenced by flood terraces and mobilization of large bedload material. The summer/fall base flows vary according to the type of water year. Observed flows during surveys varied between 25 to 40 gallons per minute (gpm). Flows increased slightly due to local thunderstorm activity, however there was evidence that the increase was short lived. A reduction of 5 to 10 gpm was observed over a period of 24 hours. There were sections where streamflow was subsurface. These sections were fluvial deposits comprised of boulders and cobbles. Where the canyon had geological nick points, the streamflow resurfaced and flowed over bedrock.

## METHODOLOGY

Herpetofauna surveys were conducted in Brushy Creek and the North Fork American River using standard protocols. The surveyed reach for Brushy Creek began upstream of the confluence of the North Fork American River and extended approximately 0.6 miles to a point where there was no streamflow. Surveys for California red-legged frogs (*Rana aurora draytonii*) were conducted according to the U.S. Fish and Wildlife Service (USFWS) protocol (USFWS, 1997). California red-legged frogs are a Federally-listed threatened species and a State Species of Special Concern-Fully Protected. Two mid-day surveys were conducted on September 9 and 14, 1998 and two night surveys were conducted on September 10 and 15, 1998. The day surveys were conducted using binoculars to scan habitats as the surveyors moved slowly upstream. When frogs were observed, identification was made visually or by capturing the individuals with a dip net. All herpetofauna were identified to species. The beginning and end time of each survey was noted. The night surveys used headlamps to detect eye shine of individual frogs. When eye shine was detected, binoculars were used to identify the individual to species.

Herpetofauna surveys were conducted along the North Fork American River for foothill yellow-legged frogs (FYLF, *Rana boylii*) and other species due to the lack of suitable habitat for California red-legged frogs (see Hiscox, 1998 for habitat description). The North Fork American River in the vicinity of the suction dredge activity is a wide, low gradient reach with deep pools and sparse riparian vegetation. Extensive gravel/cobble bars on the first flood terrace were deemed to be prime habitat for basking foothill yellow-legged frogs. The survey reach was approximately 1.0 mile in distance. The downstream starting point was approximately 200 yards upstream of the power line crossing and the end point was a large pool approximately 400 yards upstream of Mr. Emerson's parcel boundary. Both banks of the river were surveyed from downstream to upstream using binoculars to scan the area immediately upstream of the surveyors. Counts were also visually as the surveyors walked slowly upstream. All areas along the margins of the river and flood terraces were surveyed. The survey was conducted according to recognized protocols (Fellers and Freel, 1995).

## RESULTS

The Brushy Creek aquatic survey for California red-legged frogs resulted in no individuals being observed during the day or night surveys. With the exception of egg masses, all life stages of foothill yellow-legged frogs were found throughout the entire surveyed reach and one pacific tree frog (PTF, *Hyla regilla*) was also observed. The difference in survey duration times is a result of our being more familiar with the stream channel and the life stages of the individuals present in the creek (Table 1).

Rainbow trout (RT, *Oncorhynchus mykiss*) of different age classes were documented in the deeper pools and one dead riffle sculpin (SCP, *Cottus gulosus*) was found just upstream of the confluence with the North Fork American River. Western fence lizards (WFL, *Sceloporus occidentalis*) and a single alligator lizard (AL, *Gerrhonotus* spp.) were also present (Table 2).

**Table 1:** **Brushy Creek Amphibian Survey**

| Date | Species | Tadpole | Sub-Adult | Adults | Time (hrs) |
|---|---|---|---|---|---|
| 9/9/98 | FYLF | 5 | 117 | 18 | 4.33 |
| 9/10/98 | FYLF | | | 15 | 3.5 |
| 9/14/98 | FYLF | 5 | 189 | 35 | 2.5 |
| 9/15/98 | PTF | | | 1 | |
| 9/15/98 | FYLF | | 11 | 8 | 2.8 |

(Time = # of observers X hours of survey)

**Table 2:** **Brushy Creek Fish and Reptile Observations**

| Date | Species | Numbers |
|---|---|---|
| 9/9/98 | RT | 21 |
| 9/9/98 | WFL | 3 |
| 9/14/98 | RT | 23 |
| 9/14/98 | AL | 1 |

The temperature regime of Brushy Creek did not vary during the surveys. Water temperature remained a constant 70 $^0$F and did not follow diurnal air temperature fluctuations. The North Fork American River was slightly warmer due to the lack of riparian and topographic shading (Table 3).

**Table 3:** **Water and Air Temperatures**

| Date | Location | $T_{water}$ ($^0$F) | $T_{air}$ ($^0$F) | Time |
|---|---|---|---|---|
| 9/9/98 | Brushy Creek | 70 | 77 | 13:00 |
| 9/10/98 | NF Amer. R. | 73 | 75 | 13:45 |
| 9/10/98 | Brushy Creek | 70 | 70 | 21:30 |
| 9/14/98 | Brushy Creek | 70 | 87 | 13:25; 12:50 |

The North Fork American River herpetofauna survey results are presented in Table 4. No western pond turtles (*Clemmys marmorata*) were observed. Sierra garter snakes (GS, *Thamnophis couchii couchii*) were documented swimming along the margins of the river. One 14 inch rainbow trout, with a damaged eye and scales missing in caudal peduncle area, was captured with a dip net in a riffle at the downstream end of the survey reach.

**Table 4:** **North Fork American River Herpetofauna Survey**

| Date | Bank | Species | Tadpole | Sub-Adult | Adult | Time (hrs) |
|---|---|---|---|---|---|---|
| 9/10/98 | Right | FYLF | 47 | 214 | 30 | 3.0 |
| 9/10/98 | Right | GS | | | 1 | |
| 9/10/98 | Left | FYLF | 8 | 128 | 15 | 4.0 |
| 9/10/98 | Left | GS | | | 3 | |

(Time = # of observers X hours of survey)
(Right = Right Bank looking upstream)
(Left = Left Bank looking upstream)

## DISCUSSION

The large numbers of foothill yellow-legged frogs that were observed in Brushy Creek and the North Fork American River was quite surprising. This is the largest population that we know of in the Central Sierra Nevada. This species has not been found in large numbers in streams and rivers south of the North Fork American River drainage and is considered to be threatened in the Central Sierra Nevada (Jennings and Hayes, 1994). The foothill yellow-legged frog is a California

Species of Special Concern-Fully Protected and a Federal Special Concern species. There are only six known localities in the Eldorado National Forest located immediately to the south of the North Fork American River (G. Elliott, USFS pers. communication). The Rubicon River has a known population, but the viability and size have not been determined. The Tahoe National Forest is known to have more locations with larger number of individuals than the Eldorado National Forest (G. Elliott, USFS pers. communication).

The surveyed area of the North Fork American River is ideal foothill yellow-legged frog habitat with shallow, low velocity margin areas and extensive cobble bars where basking occurs. The shallow margin areas are ideal rearing areas for the tadpoles and the substrate provides extensive escape cover. The right bank had greater number of individuals of all life stages due to the habitat and substrate composition. Isolated "pot holes" did provide some habitat for tadpoles and sub-adults but this is an artifact of suction dredging activities (Hiscox, 1998). The left bank had a greater percentage of bedrock and fewer margin areas with shallow, slow moving water, thus fewer individuals of all life stages.

The large number of foothill yellow-legged frogs that were observed in Brushy Creek are not surprising give the large population in the North Fork American River. The mobility of the species would allow it to move either upstream or downstream to maintain the viability of the population. The hydrology of Brushy Creek does not allow for fish to colonize all of the instream habitat and therefore suitable refugia is available for tadpoles and sub-adults. There were sub-adults and adults observed in the same pools that rainbow trout were occupying.

The habitat along the North Fork American River was not deemed suitable California red-legged frog habitat due to the lack of riparian vegetation and low velocity habitats. Additionally, the presence of non-native smallmouth bass (*Micropterus dolomieui*) would probably preclude their ability to successfully reproduce due to predation of eggs and juveniles.

Although no red-legged frogs were observed in Brushy Creek, there is suitable habitat available. The extensive riparian vegetation and cover does not rule out the possibility of red-legged frogs being present in the canyon.

No western pond turtles were observed in either Brushy Creek or the North Fork American River in the surveyed reaches. There is anecdotal information that they have been observed in the river. Suitable habitat is present in both the mainstem river and the creek and it is highly likely that there are turtles utilizing the area.

The rainbow trout that were observed in Brushy Creek were in the larger, deeper pools where there was instream cover. Multiple age classes were observed and therefore the fish are able to survive throughout the year. During extended drought periods or during below normal water years fish may not be able to survive. However, recolonization can occur from the North Fork American River due to the lack of barriers.

## CONCLUSIONS AND RECOMMENDATIONS

There was no evidence of suction dredge activity in Brushy Creek and the Emersons stated that there are no plans to do so. There is suitable red-legged frog habitat in the creek and thus, if present, may emigrate downstream and use the North Fork American River as a migration corridor.

The channel of North Fork American River was disturbed in numerous areas by suction dredge activities. There was evidence of "high banking" and "pot holes" along the right bank of the river in the surveyed reach. These areas were being utilized by foothill yellow-legged frogs and juvenile fish were trapped in isolated holes. The frogs will be able to survive, but the fish are not likely to.

The large numbers of foothill yellow-legged frogs present in the surveyed reaches may lead to the conclusion that there is no adverse effect by suction dredge activities. However, 1995 through 1998 have been above normal water years and there is some indication that other drainages (Butte Creek) have seen a large increase in foothill yellow-legged frog numbers in recent years (K. Hill, DFG pers. communication). In below normal water years, low flows will reduce suitable margin habitat and force the frogs into areas where suction dredge activities are taking place during breeding and rearing periods. Additionally, suction dredge activities did occur upon the first flood terrace this year causing a possible adverse effect during the breeding period even in an above normal water year. There is some evidence that the egg masses of this species are highly susceptible to suspended particulates, e.g. sediment, however to what extent is unknown (Jennings and Hayes, 1994). Disruption of channel bedload in breeding areas and rearing areas will have an adverse effect upon this species.

There are numerous indications that foothill yellow-legged frogs are experiencing a statewide decline as are many other amphibian species (Jennings and Hayes, 1994). A recent follow up to a historical survey in the Yosemite National Park found no individuals at historical locations (Drost and Fellers, 1996). Therefore, it is recommended that a cautious approach be taken when considering allowing suction dredge activities that may adversely effect these and other sensitive species (Harvey and Lisle, 1998).

Thus, in order to protect the breeding and rearing habitat of the foothill yellow-legged frog a year-a-round suction dredge season cannot be recommended. The current season for this reach of the North Fork American River is from the last Saturday in May extending thru October 15. In some years the existing season may not be adequate to protect the breeding period, e.g. below normal water years. Therefore a modification of the existing season is warranted to allow a majority of the tadpoles to reach sub-adult stage where they would be able to escape any suction dredge activity. This drainage has unique characteristics for both ichthyofauna and herpetofauna, evidenced by strong populations of native minnows and amphibians. The development of more restrictive regulations that would protect these resources is warranted.

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# Exhibit 10

California Department of Fish and Game Final Environmental Impact Report
April 1, 1994
Pages 62 and 63

Discussion on turbidity and impact on water quality from by suction gold dredging

## IMPACTS ON WATER QUALITY

Suction dredging causes less than significant effects to water quality. These impacts include increased turbidity levels caused by re-suspending streambed sediments and pollution caused by spilling of gas and oil used to operate suction dredges.

The impact of turbidities on water quality caused by suction dredging can vary considerably depending on many factors. Factors which appear to influence the degree and impact of turbidity include the amount and type of fines (fine sediment) in the substrate, the size and number of suction dredges relative to stream flow and reach of stream, and background turbidities.

Because of low ambient levels of turbidity on Butte Creek and the North Fork American River, Harvey (1986, page 406) easily observed increases of 4 to 5 NTU from suction dredging. Turbidity plumes created by suction dredging in Big East Fork Creek were visible in Canyon Creek 403 feet (123 meters) downstream from the dredges (Somer and Hassler, 1992, page 251).

In contrast, Thomas (1985), using a dredge with a 2.5-inch diameter nozzle on Gold Creek, Montana, found that suspended sediment levels returned to ambient levels 100 feet below the dredge. Gold Creek is a relatively undisturbed third order stream with flows of 14 cubic feet per second. A turbidity tail from a 5-inch (12.7-cm) dredge on Clear Creek, California was observable for only 200 feet downstream. Water velocity at the site was about 1 foot per second (Lewis, 1962).

Turbidity below a 2.5-inch suction dredge in two Idaho streams was nearly undetectable, even though fine sediment, less than 0.5 mm in diameter, made up 13 and 18 percent, by weight, of the substrate in the two streams (Griffith and Andrews,1981, page 26).

Effects from elevated levels of turbidity and suspended sediment normally associated with suction dredging as regulated in the past in California appear to be less than significant with regard to impacts to fish and other river resources because of the level of turbidity created and the short distance downstream of a suction dredge where turbidity levels return to normal.

Suction dredges, powered by internal combustion engines of various sizes, operate while floating on the surface of streams and rivers. As such, oil and gas may leak or spill onto the water's surface. There have not been any reported cases of harm to plant or wildlife as a result of oil or gas spills associated with suction dredging.

The proposed regulations do not address water quality specifically, except to the extent they relate to fish, but suction dredgers are required to comply with Fish and Game Code Section 5650 which prohibits the deposition of petroleum and other materials deleterious to fish and wildlife into State waters.

5650. (a) Except as provided in subdivision (b), it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this state any of the following:

(1) Any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material or substance.

(2) Any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill, or factory of any kind.

(3) Any sawdust, shavings, slabs, or edgings.

(4) Any factory refuse, lime, or slag.

(5) Any cocculus indicus.

(6) Any substance or material deleterious to fish, plant life, mammals, or bird life.

(b) This section does not apply to a discharge or a release that is expressly authorized pursuant to , and in compliance with, the terms and conditions of a waste discharge requirement pursuant to Section 13263 of the Water Code or a waiver issued pursuant to subdivision (a) of Section 13269 of the Water Code issued by the State Water Resources Control Board or a regional water quality control board after a public hearing, or that is expressly authorized pursuant to, and in compliance with, the terms conditions of a federal permit for which the State Water Resources Control Board or a regional water quality control board has, after a public hearing, issued a water quality certification pursuant to Section 13160 of the Water Code. This section does not confer additional authority on the State Water Resources Control Board, a regional water quality control board, or any other entity.

(c) It shall be an affirmative defense to a violation of this section if the defendant proves, by a preponderance of the evidence, all of the following:

(1) The defendant complied with all applicable state and federal laws and regulations requiring that the discharge or release be reported to a government agency.

(2) The substance or material did not enter the waters of the state or a storm drain that discharges into the waters of the state.

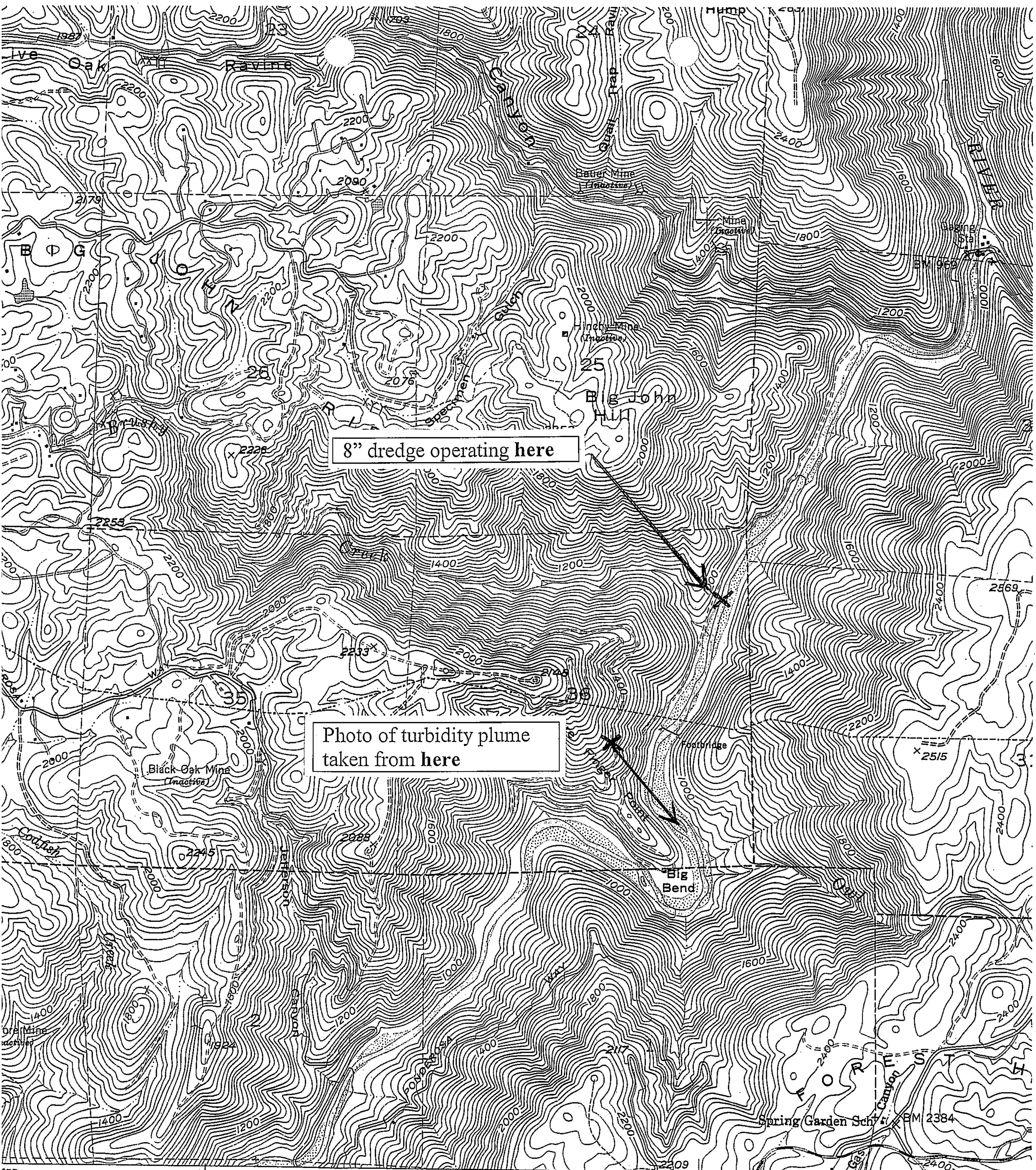
(3) The defendant took reasonable and appropriate measures to effectively mitigate the discharge or release in a timely manner.

(d) The affirmative defense in subdivision (c) does not apply and may not be raised in an action for civil penalties or injunctive relief pursuant to Section 5650.1.

(e) The affirmative defense in subdivision (c) does not apply and may not be raised by any defendant who has on two prior occasions in the preceding five years, in any combination within the same county in which the case is prosecuted, either pleaded nolo contendere, been convicted of a violation of this section, or suffered a judgment for a violation of this section or Section 5650.1. This subdivision shall apply only to cases filed on or after January 1, 1997.

(f) The affirmative defense in subdivision (c) does not apply and may not be raised by the defendant in any case in which a district attorney, city attorney, or Attorney General alleges, and the court finds, that the defendant acted willfully.

# Exhibit 11




677 678 (GREENWOOD) 1861 IV NW 679 680 55′ R. 9 E. AUBURN 14 MI. SACRAMENTO 48 MI. R. 10 E.

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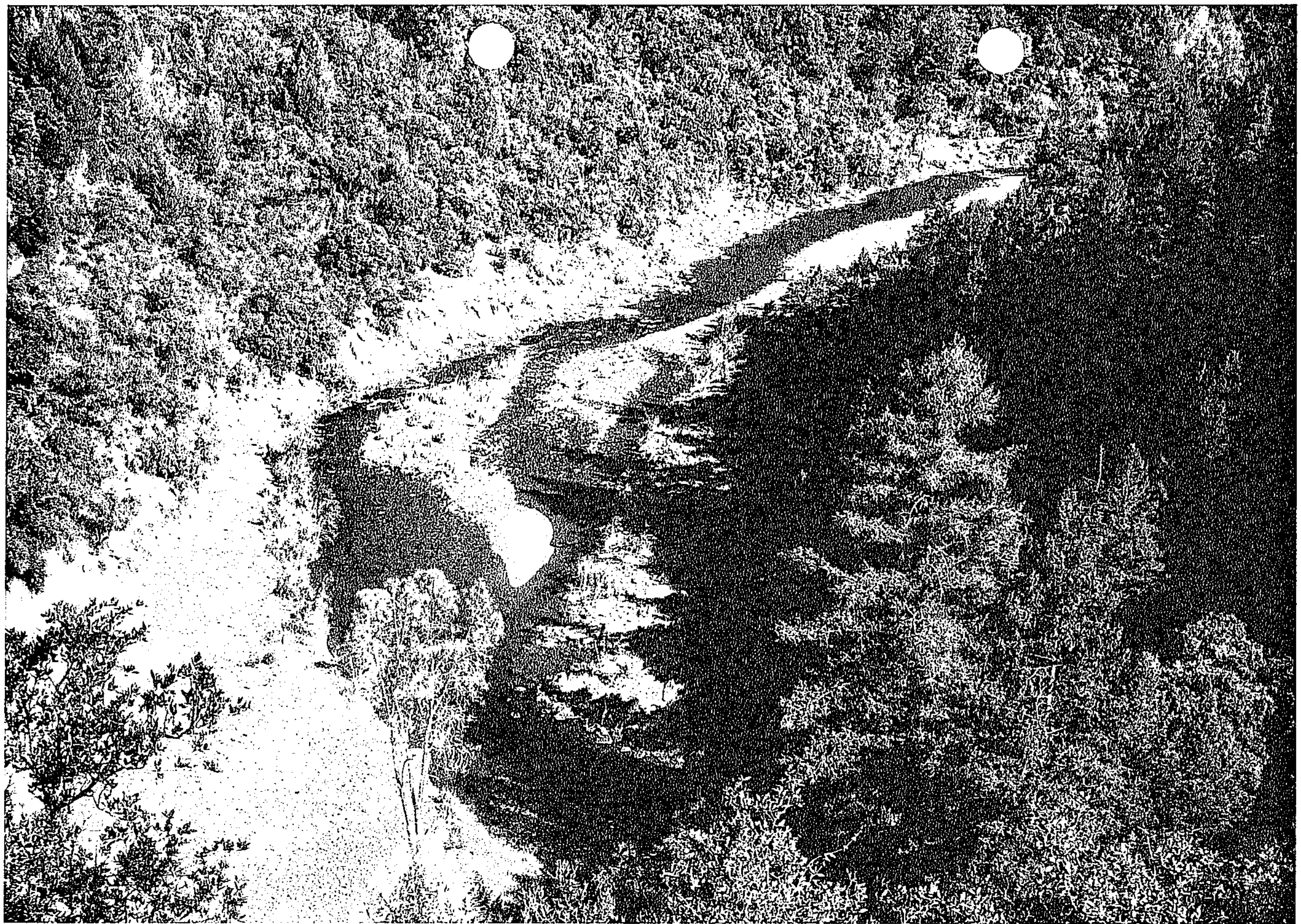
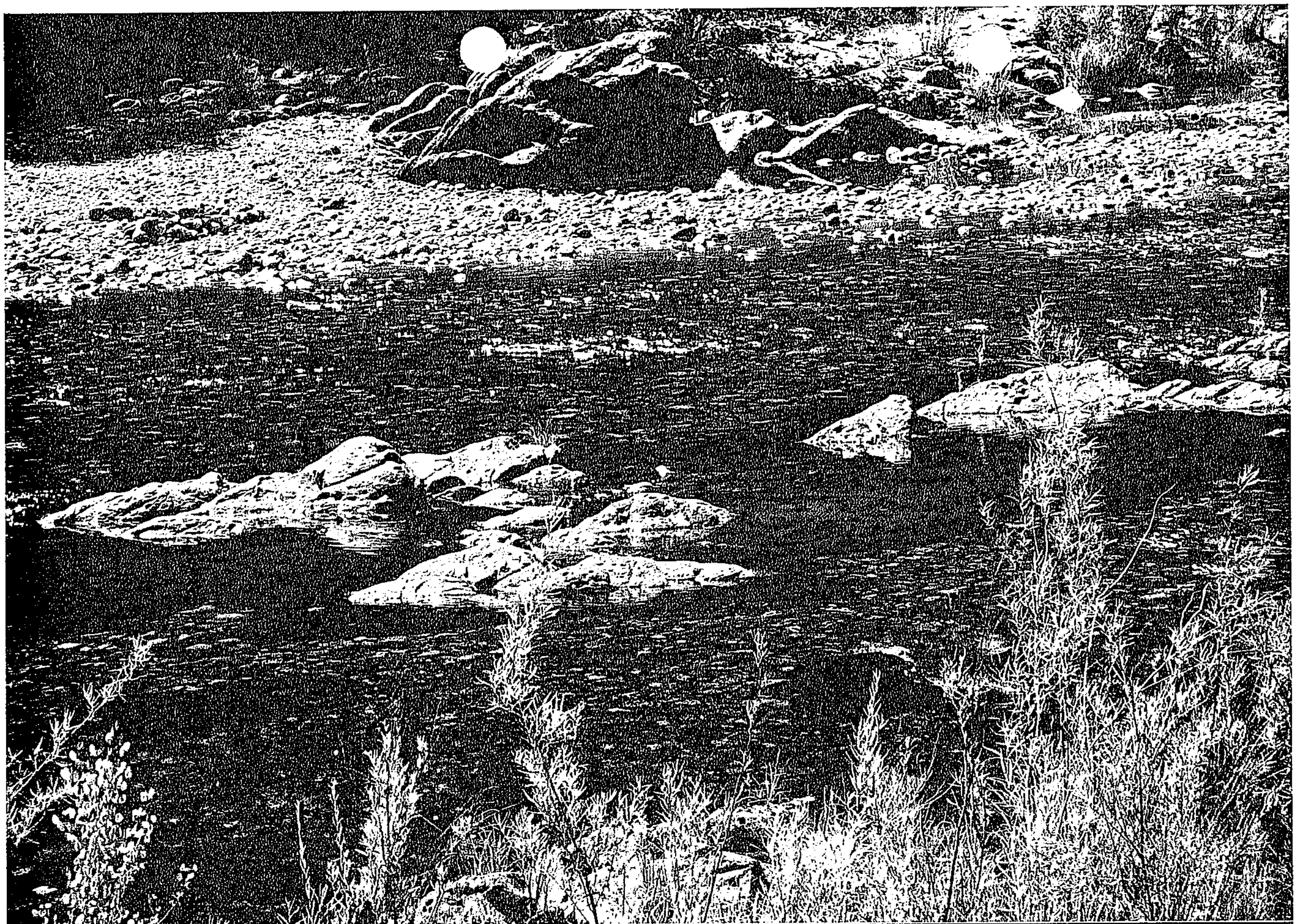
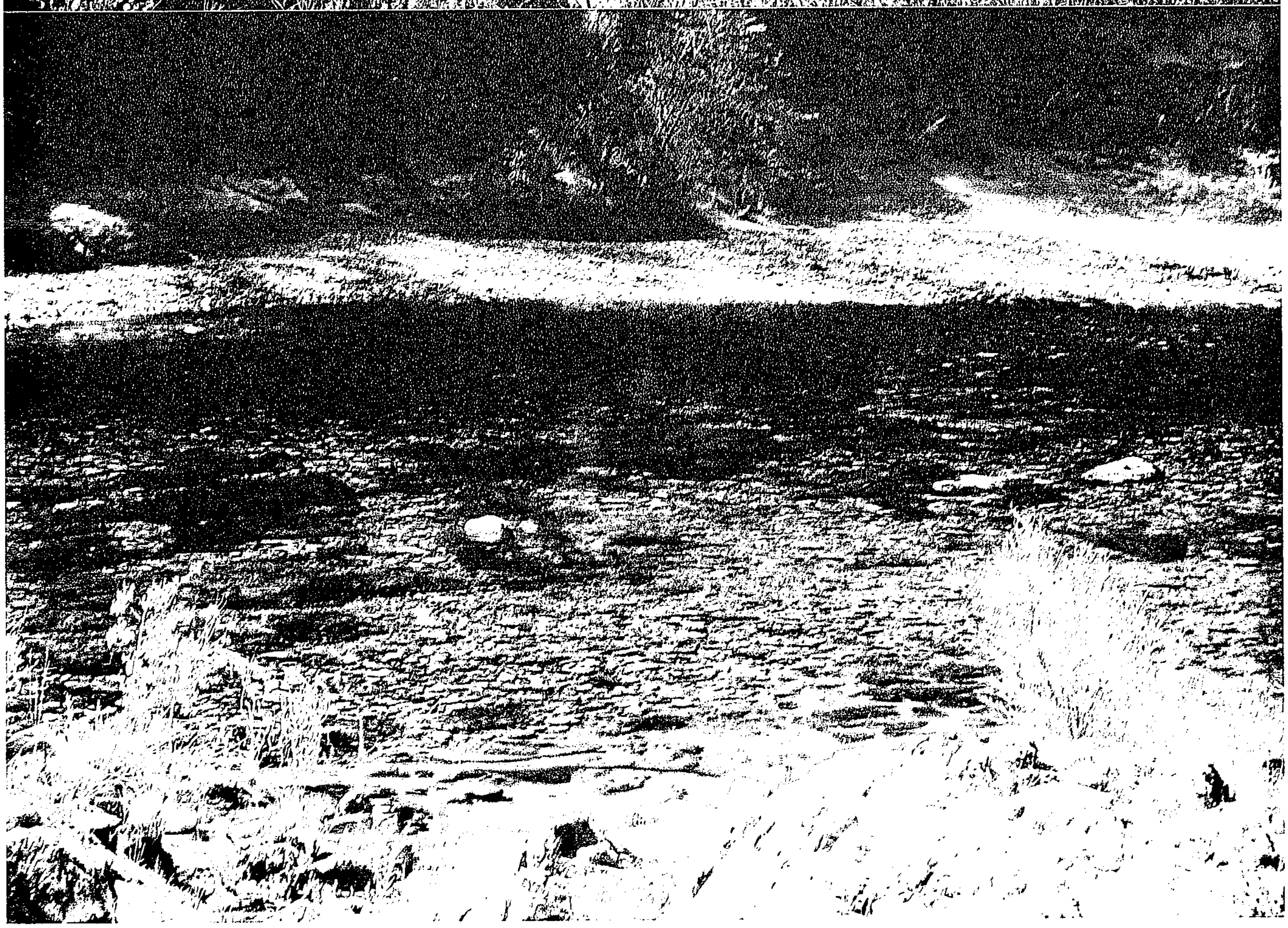
CONTOUR INTERVAL 40 FEET



NFAR
ambient
water
quality

NFAR
6/30/06

4,000
feet
downstream
of 8"
dredge
operation

# Exhibit 12

**California Department of Fish and Game**

**Biological and Aquatic Resources Assessment of Brushy Creek and the North Fork American River Placer County, California**

September 16, 1998

Key recommendations for protection of
Foothill Yellow Legged Frog from suction gold dredging activities

***(CDFG never acted upon these recommendations)***

Resource Assessment, Pages 13 and 14:

Recommends that DFG proceed with management alternative in which "DFG develops an appropriate suction dredge season regulation to reflect conditions in the subject area. Suction dredging needs to be keyed to existing FYLF (foothills yellow-legged frog) populations and Red-Legged Frog habitats. Such a regulation would have application in the NFAR (North Fork American River) from its confluence with the Middle Fork American River to the Iowa Hill Bridge Crossing. It is possible that other low-elevation systems would also be appropriate for this regulation."

# NORTH FORK AMERICAN RIVER. EMERSON SUCTION DREDGE APPLICATION SEPTEMBER 1998

MEMO

TO: Banky Curtis
FROM: John Hiscox
RE: Emerson Suction Dredge Application
CC: Villa, O'Brien, Somers, Lehr, Hill, Bolster, Randal
ATTACH: Amphibian Survey Results, Pictures of site.

At the request of Pat O'Brien, I coordinated a resource assessment for a reach of the North Fork American River (NFAR) potentially effected by a Special Suction Dredge Permit requested by Mr. Bruce Emerson. Mr. Emerson's property is located off Ponderosa Way at T14N R9E S36 in Placer County. The site is approximately 6 miles downstream of the Iowa Hill Bridge crossing and 4 miles upstream of Lake Clementine. Mr. Emerson is requesting a permit to suction dredge his private property on a yearly basis. The area is currently designated Class C.

AREA DESCRIPTION

The sampled reach of the NFAR is a wide, low-gradient system with uncontrolled flow, characterized by a mixture of cobble, gravel, sand and silt overlaying an extensive bedrock substrate. Much of the reach averaged between 80 to 150 feet wide. The reach is at an elevation of approximately 850 feet above sea level. Water temperatures are relatively warm, averaging 71 F in the mornings and 74 F by late afternoon. Cooler water persists in the bottom of deep pools and was measured at 67 F. The NFAR canyon consists of a v-shaped topography with a high scour line. Winter flows leave few perched bars out of the wetted margins, but extensive bedload movement tends to fill the canyon bottom bank-to-bank with gravels and cobble. We saw no large boulders or free standing rock within our sampling area. Gradient drops tend to occur along bedrock rifts which also maintain the limited pool habitats. Riparian vegetation is limited by scouring flows and tends to be concentrated in protected areas of bedrock or along off channel bars. The vegetation typically consists of low growing sedges, grasses, willows, alders and buttonwillow. Few areas are directly shaded by existing riparian growth.

Brush Creek is a tributary to the NFAR and enters the river from the north in section 36, within the Emerson site. On our sample dates, the stream was not contiguous with the river but was flowing in upstream areas. The drainage has extensive riparian cover and was a prime site for the amphibian surveys. As with the

NFAR, this drainage is uncontrolled and is subject to runoff events.

On our sampling dates we observed two active and several inactive suction dredge sites within our sampling area. Ongoing operations were working deposits in mid-river bars and those associated with a bedrock rift. We observed no winching equipment or winch lines, which is consistent with the lack of movable rock within the reach. A series of isolated pot-holes with tailing piles were found in one area. These holes are typical of some suction dredge activities and they were entrapping fish, although subsurface flow was maintaining fish life on the sample dates. The area may have been worked at a higher flow, but it is difficult to determine. This site was not associated with the Emerson operation. A fair amount of trash and litter associated with suction dredging was also noted at one location well within the floodplain. This area was not on the Emerson site.

## PROCEDURES

Portions of this assessment were conducted on September 9, 10, 14 and 15, 1998. Purpose of the assessment was to evaluate existing resource and habitat values at the site, and to assess the potential effects of proposed operations at the site. Fishery assessments were conducted by Bill Somers, John Hanson and myself. Amphibian assessments were conducted by Stafford Lehr and Jason Webber. Their findings are summarized under separate cover. Warden Jim Randal conducted a site visit

The fishery assessment was directed at delineating resident fish species associated with a range of habitat types occurring in the target reach of the NFAR. Fish samples were collected using two Smith Root backpack shockers. Visual surveys were conducted in pool habitats using masks, snorkels and wetsuits. Habitat types were surveyed and cataloged. A total of 5 habitat types were delineated: riffle, run, pool, backwater, and bank-dependant. A total of 16 fishery samples were taken over the 5 habitat types. Fishery sites were chosen above, below and within the proposed operating reach of the Emerson site. Macroinvertebrates were also sampled at 3 of the 16 fish sample sites: one each above, below and within the proposed Emerson site. These samples were taken with a Serber sampler.

## RESULTS

Recorded results for the fish and macroinvertebrate samples are given below. Sampling sites begin at the downstream margin of the study reach and progress upstream. Results from the amphibian surveys are summarized under separate report. Fish samples are listed as recorded by habitat type and description. Abbreviations used to describe sampled fish species are as follows:

1. SMB: Smallmouth Bass (*Micropterus dolomieui*)
2. SQF: Sacramento Squawfish (*Ptychocheilus grandis*)
3. HH: Hardhead (*Mylopharodon conocephalus*)
4. SCP: Riffle Sculpin (*Cottus gulosus*)
5. SKR: Sacramento Sucker (*Catostomus occidentalis*)
6. RT: Rainbow Trout (*Oncorhynchus mykiss*)
7. FYLF: Foothill Yellow-Legged Frog adult (*Rana boylei*)
8. FYLF-t: Foothill Yellow-Legged Frog tadpole (*Rana boylei*)

Site-specific data for fishery samples are presented below. Data for Site A includes length frequency measurements for sampled fish. Later sites only included length measurements for fish outside of established size ranges. Some categories include combined data for SQF and HH . Juvenile of these species frequently occurred together in large numbers and were difficult to differentially key. Subsamples indicate that SQF generally constitute 90% and HH 10% of such samples.

SITE A

Location: Approximately 100 ft. upstream of powerline crossing in section 36.
Area: 290 x 70 feet.
Habitat: Riffle, flat water. 10 inches deep. Gravel, cobble, sand. Limited low riparian.

| | |
|---|---|
| SMB: | 9 (3.2-5.5 inches) |
| SKR: | 3 (2..1-2.9 inches) |
| SCP: | 110 ( 0.2-4.5 inches) |
| SQF/HH | 9 (2.0-2.5 inches) |
| FYLF | 4 ( 1.5-2.3 inches, nose to foot) |
| FYLF-t | 3 ( 0.8-1.1 inches) |

Observations: Many SCP uncounted. Adult FYLF abundant on bank. One 12-14 inch Garter Snake sighted on bank.

SITE B

Location: South side of river. Just below rock outcrop at Emerson hole.
Area: 60 x 25 feet.
Habitat: Run, quiet water. Bedrock bottom, cobble and gravel overburden. One pool. Bank cover with limited overhanging grass. Fissures to 6 inches.

SQF: 1
SCP 55
SKR 1
FYLF-t 2
FYLF 1

SITE C

Location: North side of river. Just downstream of Emerson trailer site. Pump intake upstream.
Area: 70 x 20 feet.
Habitat: Shoreline-oriented quiet water. Bedrock shelf with large cobble and gravel. Overhanging grass.

SMB: 9
SCP: 25
FYLF-t 6
FYLF 5

Observations: Large caddis cases everywhere, even in scour zone. Garter snake seen in grass.

SITE D

Location: North side of river along large pool adjacent to Emerson trailer. Pump intake within reach.
Area: 80 x 10 feet.
Habitat: Pool. Cobble margin on bedrock. Limited gravel. Deep ledge. Willows and grasses on bank, limited overhang.

| | |
|---|---|
| SMB: | 13 |
| SQF/HH | 6 |
| SKR | 3 |
| FYLF-t | 7 |
| FYLF | 2 |

Observations: Dipper observed working upstream riffle. Five adult Mergansers on pool. Two Fence Lizards seen on bedrock shelf.

SITE E

Location: South side of river adjacent to large pool. Slightly upstream of Site D.
Area: 50 x 10 feet.
Habitat: Pool. Bedrock shelf with sedges and overhanging grasses. Root rhizomes in water. Shade component.

| | |
|---|---|
| SMB: | 12 |
| SQF/HH | 18 |
| FYLF-t | 6 |

SITE F

Location: South side of river, just upstream of Brush Creek confluence.
Area: 100 x 20 feet.
Habitat: Riffle. Moderate flow. Water to 16 inches. Cobble and gravel. No riparian. Riffle break of 2-3 feet downstream.

| | |
|---|---|
| RT: | 1 (3.8 inches) |
| SQF/HH | 32 |
| SCP | 44 |
| FYLF-t | 24 |
| FYLF | 11 |

Observations: Unknown Hemiptera seen. Chomps the net!

SITE G

Location: North side of river adjacent to Ascari claim. Active dredge site.
Area: 65 x 15 feet.
Habitat: Run/pool. Quiet water. Extensive bedrock with fissures and pockets of cobble and gravel. Root growth in water. Grasses, sedges and alders on bank.

| | |
|---|---|
| SMB: | 9 |
| SKR | 3 |
| SQF/HH | 105 |
| FYLF-t | 15 |
| FYLF | 3 |

Observations: Fish concentrated in backwater area along plants. Work site with higher velocities, few fish.

SITE H

Location: South side of river. Within Ascari claim. Upstream of Site G.
Area: 30 x10 feet.
Habitat: Riffle. Fast water. Water to 12 inches. Cobble and gravel . No riparian.

SCP: 26

Observations: Dipper working upstream riffle.

SITE I

Location: South side of river. Isolated dredge hole.
Area: 15 foot diameter hole.
Habitat: Isolated hole, gravel. Subsurface flow.

| | |
|---|---|
| SQF: | 35 (4.2-5.3 inches) |
| HH: | 2 (4.2) |
| SMB: | 1 |
| SKR: | 2 |
| FYLF | 1 |

Observations: Garter snake feeding on fish in hole. Regurgitates 5.0 SQF .

SITE J

Location: North side of river. Immediately upstream of Emerson boundary (as marked) in active dredge site.
Area: 100 x 15 feet.
Habitat: Run/shore oriented. Quiet water. Bedrock bank with abundant bunch grasses, sedges, small willows and wetted plant roots. Shadow component.

| | |
|---|---|
| SMB: | 2 |
| SQF/HH | 255 |
| SCP: | 2 |
| SKR: | 9 |
| FYLF-t: | 9 |

Observations: SQF/HH likely an underestimate. Difficult to collect. Prime nursery site.

SITE K

Location: South side of river, immediately downstream of Emerson dredge.
Area: 50 x 10 feet.

Habitat: Shore oriented quiet water. Undercut bank with exposed roots of downed trees. Gravel with limited cobble.

| | |
|---|---|
| SQF/HH: | 6 |
| FYLF-t | 2 |
| FYLF | 1 |

Observations: Appears that past disturbance has led to recent tree collapse. May be result of natural or man-induced event. Habitat created minimal.

SITE L

Location: South side of river. Immediately upstream of Emerson boundary (as marked).
Area: 70 x 25 feet.
Habitat: Riffle/run. Slow water. Continuous with expansive riffle. Cobble and gravel with bedrock outcrops. Minor grasses and alders, exposed plant roots in water.

| | |
|---|---|
| SMB: | 5 |
| SCP: | 32 |
| SKR: | 8 |
| SQF: | 7 |
| HH: | 2 |
| FYLF-t: | 15 |
| FYLF: | 4 |

SITE M

Location: South side of river. Upstream of Emerson boundary, upstream of Site L (approximately 1 mile above power line crossing at Site A).
Area: 100 x 25 feet.
Habitat: Shore oriented run. Separated channel with gravel and sand bottom. Bedrock outcrop on banks. Riparian shade with low grasses, willows and alders.

| | |
|---|---|
| SMB: | 1 |
| SCP: | 78 |
| SQF: | 16 (3.8-4.2) |
| SQF/HH: | 26 |
| SKR: | 8 |
| FYLF-t: | 8 |
| FYLF: | 9 |

Observations: Garter snake on exposed ledge. Large (3.5 in.) FYLF on bank.

SITE N

Location: North side of river. Opposite bank from Site M, separated by extensive submerged gravel bar.
Area: 50 x 15 feet.

Habitat: Run. Quiet water with several small pools in bedrock. Riparian with bunchgrasses, alders. Minor shade component.

| | |
|---|---|
| SMB: | 6 |
| SQF/HH: | 13 |
| SCP: | 12 |
| FYLF-t: | 1 |
| FYLF: | 2 |

SITE O (SNORKEL SURVEY SITE)

Location: Large deep pool at Emerson trailer site (Site D sample area).
Area: Pool size approximately 250 x 85 feet.
Habitat: Bedrock cavity with some large cobble and gravel deposits. Deep bedrock shelves. Riffle curtain at upper end of pool. Colder water at pool bottom.

Results are visual sightings with total length estimates in inches.

| | |
|---|---|
| RT: | 10 (5 @ 8", 4 @ 10", 1 @ 12") |
| SMB: | 9 (1 @ 5", 2 @ 6", 2 @ 10", 2 @ 12", 2 @ 14") |
| SQF/HH: | 13 ( 2 @ 12", 5 @ 15", 5 @ 24", 1 @ 27") |
| SKR: | 59 ( all 12 to 15 inches) |

Observations: SQF and RT at riffle curtain, SKR in large ball in quieter water. Unable to reach pool bottom, sample deepest ledges. Estimated pool depth 25 feet.

SITE P (SNORKEL SURVEY SITE)

Location: North side of river at Ascari claim. Adjacent to sample sites G and H.
Area: 75 x 35 feet.
Habitat: Fast water run. Bedrock pool with deep trenches. Water depth to 5 feet. Extensive turbulent water.

Results are visual sightings with total length estimates in inches.

| | |
|---|---|
| SMB: | 4 (1 @ 6", 1@ 8", 2 @ 12") |
| RT: | 1 ( 8") |

Observations: Difficult to see with failing light and turbulence at riffle curtain.

## MACROINVERTEBRATE SAMPLES

Macroinvertebrate samples were taken using a Serber Sampler within site areas A, F, and M. Sampled areas were outside electrofished areas. Three-minute scrubs were conducted to obtain the samples. Sorting and keying were conducted on-site to genera, as possible. The following genera were found in all 3 samples.

| | |
|---|---|
| Caddis sp. | Caddisfly larvae |
| Ephemeroptera sp. | Mayfly larvae and cases. |
| Plecoptera sp. | Stonefly larvae and cases |
| Odanata sp. | Dragonfly larvae |
| Diptera sp. | Midges |
| Coleoptera sp. | Beetles |
| Hemiptera sp. | Unknown, backswimmer-like |
| Annelida sp. | Segmented worm |
| Platyhelminthes sp. | Flatworm |

No qualitative difference was obvious in numbers or variety of macroinvertebrates between sample sites. Caddis larvae predominated at all sites. A comprehensive rapid bioassessment would be necessary to delineate between sites within the study reach, but the need is probably lacking. A dark brown algae was present at all sites lacking high velocities or suction dredge activity. The algae was confined to rock surfaces and did not blanket all substrates.

## AMPHIBIAN SURVEYS

Surveys for resident amphibians were conducted using United States Fish and Wildlife Service (USFWS) protocols^for Red-Legged Frog (Rana aurora) on Brushy Creek. Foothill Yellow-Legged Frog surveys (Rana boylii) were conducted on the NFAR as per Fellers and Freel, 1995. Detailed results of these surveys are contained in Attachment A to this document. The surveys documented the numerous Foothill Yellow-Legged Frogs seen and defines their habitats. The survey did not document the presence of Red-Legged Frogs, but does describe potential habitat sites.

## DISCUSSION

The NFAR within this study reach is essentially a warmwater fishery with a marginal coldwater component. Available habitats favor the SQF, HH, SCP and SKR. SMB utilize all of the quiet water components while the RT are limited to what little colder water exists in the area. An unexpected result was the large numbers of FYLF found throughout the study reach. The FYLF were utilizing every habitat type sampled either as tadpoles or adults. Whether or not the success of the FYLF can be attributed to a late water year is unknown. High flows persisted in this area through June and dredging activity did not begin in the area until July. Brush Creek also maintained good numbers of adult FYLF in the available habitats near its confluence with the NFAR.

Essentially all of the fish and amphibian species recorded in our samples are spring spawners, and are at the mercy of the uncontrolled flows of the NFAR. Available habitat types monitored in this sample would be vastly different at higher or lower flows. We do not know which type of water year favors which species in this section of river. The balance of available pool, riffle, run and quiet water habitats is likely to change yearly. Management strategy is forced to concentrate on timing of habitat usage rather than the distribution of the available habitats themselves.

Species which may have been expected in the sample area, but were not found, include: Brown Trout (Salmo trutta), Western Pond Turtle (Clemmys marmorata) and Crayfish (Astacus nigrescens). High water scour flows may limit the ability of the Pond Turtle or Crayfish to persist. The absence of the Brown Trout may be habitat or competition related.

## MANAGEMENT ALTERNATIVES

Historically, suction dredge regulations administered by DFG have utilized salmonids as target indicator species to determine appropriate dredging seasons for maintaining fish and wildlife resources. In general, this approach has adequately protected other species associated with these coldwater environments. The reach of the NFAR addressed in this report is an example of a system maintaining significant resource values other than those found with salmonids. The mixture of native minnows, native non-game fish, frogs and introduced centrarchids presents the fishery manager with the question of how best to protect these resource values. Below are my thoughts on possible alternatives for suction dredging in this reach of the NFAR:

1. DFG maintains existing Class C classification. Spring and fall periods protected from human activity. Existing resources are keyed to spring spawning, and are partially protected, although not fully for FYLF. No CEQA document required, but recommended changes are likely for programmatic document in future.

2. DFG allows year-around dredging under a Special Suction Dredge Permit. Resources present are at an (undetermined) level of risk from human impacts superimposed on the ephemeral flows of the subject watershed. High flow years are likely to produce less human impact than low-flow years. Habitat availability is uncertain year-to-year, but the spring spawning activity of all species is likely to be impacted to some degree by dredging activity. Suction dredge process will require yearly CEQA documents for a Special Permit. This process will require on-site inspections, resource assessment surveys and will require a major commitment of time and personnel.

3. DFG issues a modified Special Suction Dredge Permit so as to protect spring spawning periods while allowing limited summer dredging. This option more restrictive than existing Class C regulation, and will require CEQA process.

4. DFG develops an appropriate suction dredge season regulation to reflect conditions in the subject area. Suction dredging needs to be keyed to existing FYLF populations and Red-Legged Frog habitats. Such a regulation would have application in the NFAR from its confluence with the Middle Fork American River to the Iowa Hill Bridge Crossing. It is possible that other low-elevation systems would also be appropriate for this regulation.

## RECOMMENDATIONS

Given the current climate of resource management, DFG should take a proactive stance, when possible, in managing the fish and wildlife within its jurisdiction. The issues in this instance involve native non-game species and a species-of-special-concern that may be effected by suction dredge activity. It seems appropriate for DFG to address this issue now, before further listings or regulatory demands necessitate action. I recommend DFG proceed with Management Alternative #4 listed above, with the interim application of Management Alternative #1 until appropriate regulations are in place.

John I. Hiscox
Associate Fishery Biologist
September 15, 1998

# Exhibit 13

Linda S. Adams
*Secretary for Environmental Protection*

# State Water Resources Control Board

**Division of Water Quality**
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
FAX (916) 341-5463 • http://www.waterboards.ca.gov

Arnold Schwarzenegger
*Governor*

## NOTICE OF PUBLIC WORKSHOP ON SUCTION DREDGE MINING

Tuesday, June 12, 2007
10:00 a.m.
Resources Building
First Floor Auditorium
1416 9th St.
Sacramento, CA 95814

**NOTICE IS HEREBY GIVEN** that the State Water Resources Control Board (State Water Board) will hold a public workshop regarding suction dredge mining. The purpose of this workshop is to accept public comments regarding the effects of suction dredge mining on water quality. Comments should be limited to the water quality concerns associated with suction dredge mining. The public, organizations, agencies, tribes, and other interested parties are encouraged to attend and participate in this workshop.

The U.S. Army Corps of Engineers (ACOE) issued a general certification for suction dredge mining activity. This certification expired in 2000 and was not renewed. In response to the ACOE's certification, the State Water Board issued a Clean Water Act (CWA) 401 General Certification. When the ACOE's certification expired in 2000, the State Water Board's certification also expired. The Department of Fish and Game issues permits for suction dredge mining under Section 5653 of the Fish and Game Code.

In order to protect the quality of California waters, the State Water Board is reviewing the water quality impacts of suction dredge mining. The workshop is intended to allow the State Water Board to hear public comments regarding the effects of suction dredge mining on the quality of the waters of the State. The State Water Board will then assess the available information to evaluate a possible further course of action..

**SUBMISSION OF SUCTION DREDGE MINING COMMENTS:**

The State Water Board will accept both written and oral comments concerning the effects of suction dredge mining on water quality. Comments should be limited to the effects of suction dredge mining on water quality. Comments received by 12 p.m. on June 22, 2007 will be given full consideration. Written comments should be submitted to: Song Her, Clerk to the Board, Executive Office, State Water Resources Control Board, P.O. Box 100, Sacramento, CA 95812-0100. (Fax: 916-341-5620 or email: commentletters@waterboards.ca.gov). Please indicate the project you are commenting upon in the subject line, “Comment Letter – Suction Dredge Mining.” Electronic submission via email is preferred.

**UPDATES AND INFORMATION VIA EMAIL SIGNUP**

In order to receive information regarding suction dredge mining, you may utilize the link http://www.waterboards.ca.gov/lyrisforms/swrcb_subscribe.html to sign up for email notification.

**PARKING AND ACCESSIBILITY:**

There is a fee parking garage with an entrance on 10th Street (at the corner of P Street), and there are limited metered parking spaces in the vicinity of the building. Public transit via Lightrail is located at the 8th and O Street station.

May 15, 2007
Date

Song Her
Clerk to the Board

**California Regional Water Quality Control Board**
**Central Valley Region**
Robert Schneider, Chair

Linda S. Adams
*Secretary for Environmental Protection*

Sacramento Main Office
11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.waterboards.ca.gov/centralvalley

Arnold Schwarzenegger
*Governor*

6 December 2006

Alison Harvey
Friends of the North Fork
3781 E. Pacific Avenue
Sacramento, CA 95820

PUBLIC RECORDS ACT REQUEST – WATER QUALITY CERTIFICATIONS FOR SUCTION DREDGE MINING

Your 21 November 2006 letter to Robert Schneider has been referred to me for a reply. Mr. Schneider's term as a Board member has expired and he is no longer the Regional Water Board Chair.

You requested information on the number of certifications or waivers that have been issued by the Regional Water Board for suction dredging activities below the 4000-foot elevation in Amador, Calaveras, El Dorado, Mariposa, Nevada, Placer and Tuolumne Counties. I have discussed this with staff and we are not aware of any certifications or waivers for suction dredging that have been issued by the Regional Water Board.

The Department of Fish and Game's (DFG) Section 5653 regulations provide regulatory authority over suction dredgers and DFG issues permits for suction dredgers. Since the DFG issues permits for these dredgers, we would like to rely on the DFG and the local wardens to alert us of problems. We have a good working relationship with the DFG. Further, we will meet with DFG staff and State Water Resources Control Board staff in the near future to discuss this issue.

If you wish to discuss this issue, please call me at (916) 464-4670.

William J. Marshall

William J. Marshall, Chief
Storm Water and
Water Quality Certification Section

# Exhibit 14

Auburn Journal



# News

## Firefighters stopping Ponderosa blaze

*By Bruce Schuknecht, Journal Staff Writer*

An army of firefighters have nearly halted the once raging 2,750-acre Ponderosa fire inside the American River Canyon, according to the California Department of Forestry.

Early Tuesday, the 2,100-strong force and tons of equipment had all but encircled the estimated 4¼-square-mile wildfire that cost an estimated $3.1 million to stop during the 4½-day blaze, CDF reported. Monday the wildfire had peaked and also threatened homes on its northern flank near Colfax, CDF also said.

Sunday, several neighborhoods near the canyon rim, south of Colfax, were urged to evacuate. Then late Monday, the all-clear was signaled.

Throughout Monday night, another estimated 300 acres was charred, said Tina Rose, a CDF fire prevention specialist, but that was partly due to crews setting backfires to help strangle the blaze.

Early Tuesday, crews began strengthening fire lines and started mopping up the charred areas, dousing and snuffing out hot spots, said Rose. That work was expected to last throughout the weekend.

As the hard work began tapering off, fire managers scheduled a town-hall style meeting for residents affected by the blaze to learn about firefighting efforts, Rose said. The gathering is set for 7 p.m. tonight at Sierra Vista Community Center in Colfax, at 55 School St.

"When we have big fires like this, we want to have a community meeting," she said, predicting a turnout of 50 to 100 people.

As crews search for hot spots over the coming days, residents should watch for big fire equipment traveling along narrow rural roads that board the burned areas, she said.

Meantime, fire investigators had already determined what started the wildland blaze on Friday afternoon, near Ponderosa and Yankee Jim roads, which is near Bruce Fouts' small gold mining operation, fire officials reported. The area is near a spot called Sore Finger, close to the river, said CDF Capt. Mark Koenig, a fire investigator.

He confirmed that it was Fouts, in his 60s, who reported his old Chevy pickup ignited a fire that accidentally set off wildland blaze. Fouts, who lived in rustic conditions, had no phone, and dashed off to find a phone, the captain said.

"There was backfire in the (truck) carburetor, and the engine caught on fire," Koenig said, "and that caught the grass on fire." The miner drove a second vehicle to find help, the captain Tuesday.

"The pickup started the fire. It was accidental," he said. "There was no criminal intent."

Koenig added that he did not plan to cite Fouts for the fire.

Fouts' pickup was charred, as well as his camper where he lived and mined near the river for gold, the captain said.

Fouts, who apparently was displaced by the destruction, could not be reached for comment.

However, property co-owner Alison Harvey of Sacramento said she examined her property Saturday and saw that Fouts' camper, his apparent humble quarters, was still intact. She also claimed that Fouts was staying on the land without her permission.

On Monday, the property's other owner declined commenting on the record about what happened

# CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

## NEVADA-YUBA-PLACER UNIT

## FIRE PREVENTION BUREAU

| | |
|---|---|
| INCIDENT DATE: | August 17, 2001 |
| INCIDENT NUMBER: | CANEU14446 |
| FIRE NUMBER: | 708 |
| CASE NUMBER: | N/A |
| INCIDENT NAME: | PONDEROSA |
| VIOLATION: | N/A |
| TYPE: | WILDLAND |
| CAUSE: | VEHICLE |

REPORTING OFFICER: MARK A. KOENIG, FIRE CAPTAIN SPECIALIST
NEU FIRE PREVENTION/LAW ENFORCEMENT

## 2 – SUMMARY:

On Friday, August 17, 2001, at approximately 3:00 P.M., I responded to a wildland fire to identify the cause and origin. The fire was reported to have started in the area of the American River North Fork, between the Ponderosa and Yankee Jim Bridge crossings. I was advised by the Emergency Command Center the reporting party stated he was responsible for the ignition of the fire.

I made telephonic contact with **S-1 FOUTS** at approximately 7:00 P.M. He advised me he was parked on a dirt road at the gold dredging claim he was in partnership with **W-3 EMERSON**. **S-1 FOUTS** stated he had went to start his pickup, heard a backfire and the engine stopped. He tried to restart the pickup, noticed smoke coming from under the hood, and on investigation he saw fire and left in another truck to get help.

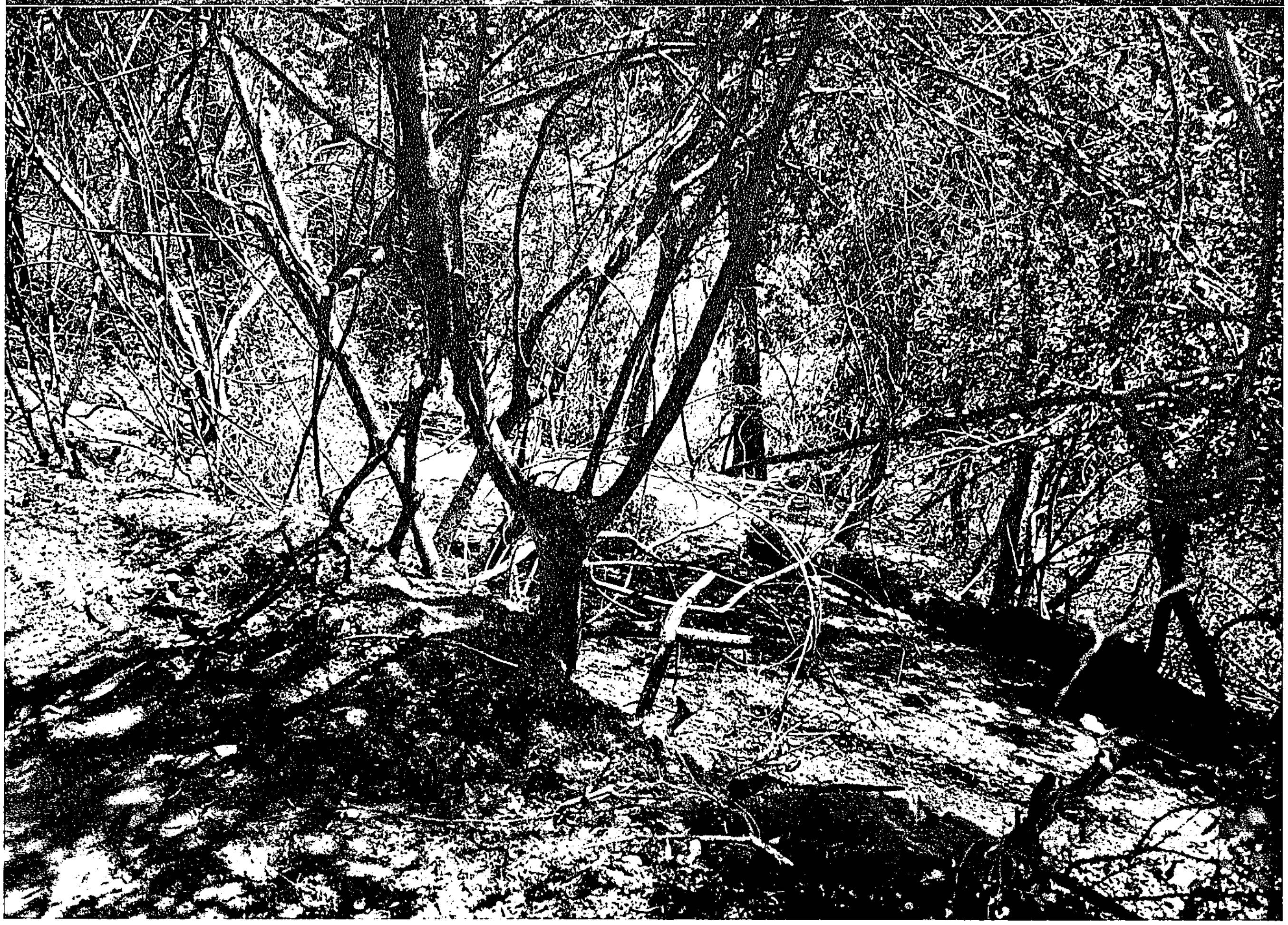
At the scene of the fire origin I found a 1982, full size Chevrolet pickup. The vehicle was completely burned with burn indicators showing extension from the vehicle into the wild land. Investigation of the engine compartment hood shows indications that there was a longer burning more intense fire in the area of the right firewall (refer to PHOTOs E through G).

By my observation, training, and experience I believe the fire was ignited from a backfire of the internal combustion engine through the carburetor into the engine compartment. I do not believe the absence of the air filter in the canister contributed to the extension of the fire into the engine compartment. Due to the extent of damage I am unable to conclude if there was any hydrocarbon residue present in the engine area that would contribute to the fire ignition or extension.

The wildland fire is a direct result of an extension from the vehicle.

Mark A. Koenig, #1760
Fire Captain Specialist


201·BHE



# Exhibit 15

Garbage and Sanitation

The proposed project would permit activities in streams throughout California. McCleneghan (1983), found that 13 percent of the suction dredge miners camped in the riparian areas adjacent to the suction dredge mining operations. Assuming that there are presently approximately 4,480 suction dredgers, about 582 suction dredgers and an unknown number of family members and work partners camp in riparian areas. McCleneghan and many Department wardens have often observed camps strewn with household garbage, industrial waste, 55 gallon cans, old dilapidated vehicles and human waste. The Department can cite for violations related to garbage disposal within 150 feet of any water of the State under Section 5652 of the Fish and Game Code. Many suction dredge operators have reported that they often remove garbage left by other river users, particularly submerged garbage. The proposed regulations do not address the issues of garbage disposal. However, suction dredgers are subject to Fish and Game Code Section 5652, the law prohibiting littering.

Prolonged usage of a suction dredge site inevitably results in the need for sanitation facilities. Many operators stay in the same location for several weeks at a time. Some national forests require suction dredge operations to include self-contained toilet systems with holding tanks capable of use for several weeks. The sanitation problem is within the jurisdiction of the Local and State Health Departments, State Regional Water Quality Control Boards and federal land managing agency.

Testimony, 1/11/94 WPW hearing

Dean Swickert, Area Manager, BLM

"My name's Dean Swickert. I'm the area manager with the Bureau of Land Mgmt, which is the United S. Dept of the Interior.

..The area that I'm administrator of basically covers from Yuba County to Fresno County, so most of the Mother Lode, and I get to see a great deal of mining. In fact I administer 10,000 mining claims, so I have, I think, quite an in depth understanding of dredging.

"We see a significant number of problems with trespass associated with dredging for a couple of reasons. One is that most dredging takes place in rural areas and it requires a great deal of equipment, so when you move in a dredge and gasoline and all the support it takes, it normally establishes some sort of a camp with that. And because it's in a rural area and because it's the Mother Lode there tends to be a lot of boundaries between private and public land. So we see this trespass occurring because of the nature of the activity and because the boundaries are not clear.

"And so a private landowner, and I see this with ranchers -- I see it with timber operators in particular, they'll have holdings of land and there'll be trespass established and before they can do much about it it's of fairly large size.

"Most dredgers behave themselves. Some don't. Those that don't can create real problems, especially when they create an encampment. And I brought a few photos, I'm not sure if they're similar to photos that were shown earlier, but once these encampments become started the people become territorial. And once they become territorial they will either by force or by intimidation try and keep people off either the public land or even off of their own private lands, so it's a significant problem.

"Also there's hazards. There's certainly a health hazard. They usually defecate in five gallon cans or into the stream and that sort of thing. A bigger problem is fire. These camps are generally fire hazards because they simply don't adhere to what most people would consider responsible behavior.

"I've dealt with maybe 1,000 of these cases in the last ten years and I think they contribute a substantial problem out there. One, because of this intimidation of public land and private land users. One is because of pollution. Another is because they're a subsistence economy, cutting down trees for firewood, taking wildlife as they need it just to subsist. So its a significant problem both on public and on private land.

"We don't take a position on this bill one way or the other, but I hope we can give you at least some idea of the magnitude of the problem."

[Discussion by various committee members followed, with questions to Assemblyman Hauser. Mr. Swickert's next discourse followed a question from Assemblyman Knowles.]

Knowles: "... my second question is that it would seem to me that

if we are taking a legislative approach to enhance the fine, enhance the jail sentence, et cetera, and to really mitigate this, it would be very appropriate to document the need involved ... and your photos are very illustrative, but do you have any numerical quantification about how big a problem this really is before we jump into a legislative solution to whack these guys that are the abusers?"

Hauser responded that anecdotal information was available, because it is difficult to establish trespass.

Swickert: "We have numbers, and I'll tell you what we have on public land and I can also tell you, from my private observations, what we have on private land as well.

"In the last ten years we've done 1,000 cases of trespass, of which 500 have dealt with dredging on public land."

Knowles: "What time period was this...?"

Swickert: "This was over ten years -- this is the number of cases we've completed. We normally run about 200 cases behind. We normally do 100 a year and we get 100 new ones a year, so we're basically treading water. Not all of those..."

Knowles: "So you're getting about 50 cases a year then on the average, over the last decade, that are suction dredging related trespass."

Swickert: "Right... and we'll get about that many more. Now understand that we administer 19 counties and we have three enforcement personnel, so that doesn't mean we're finding them all."

Knowles: "I understand. Another question is -- help me make a connection here. How is it that you, as representing BLM, are entertaining private property trespass complaints?"

Swickert: "What happens is, public and private lands are intermixed in the Mother Lode, and usually when there's a problem that comes up with trespass, and remember that dredging is related to streams and the Bureau usually has some involvement in that, so the sheriff's office or the wardens in the BLM generally work together.

"And in fact, what you'll find is some of these trespassers will deliberately find the soft spots between private and public land, and that's where they'll set up and they'll tell both enforcement agencies, for example, if the sheriff's out there, they'll say they have permission from BLM, where if we're out there, they'll say they have private landowner permission, and so it's very difficult to deal with that.

"But in terms of numbers, I would say we're dealing with 50 to 100 cases a year, of which we resolve 50."

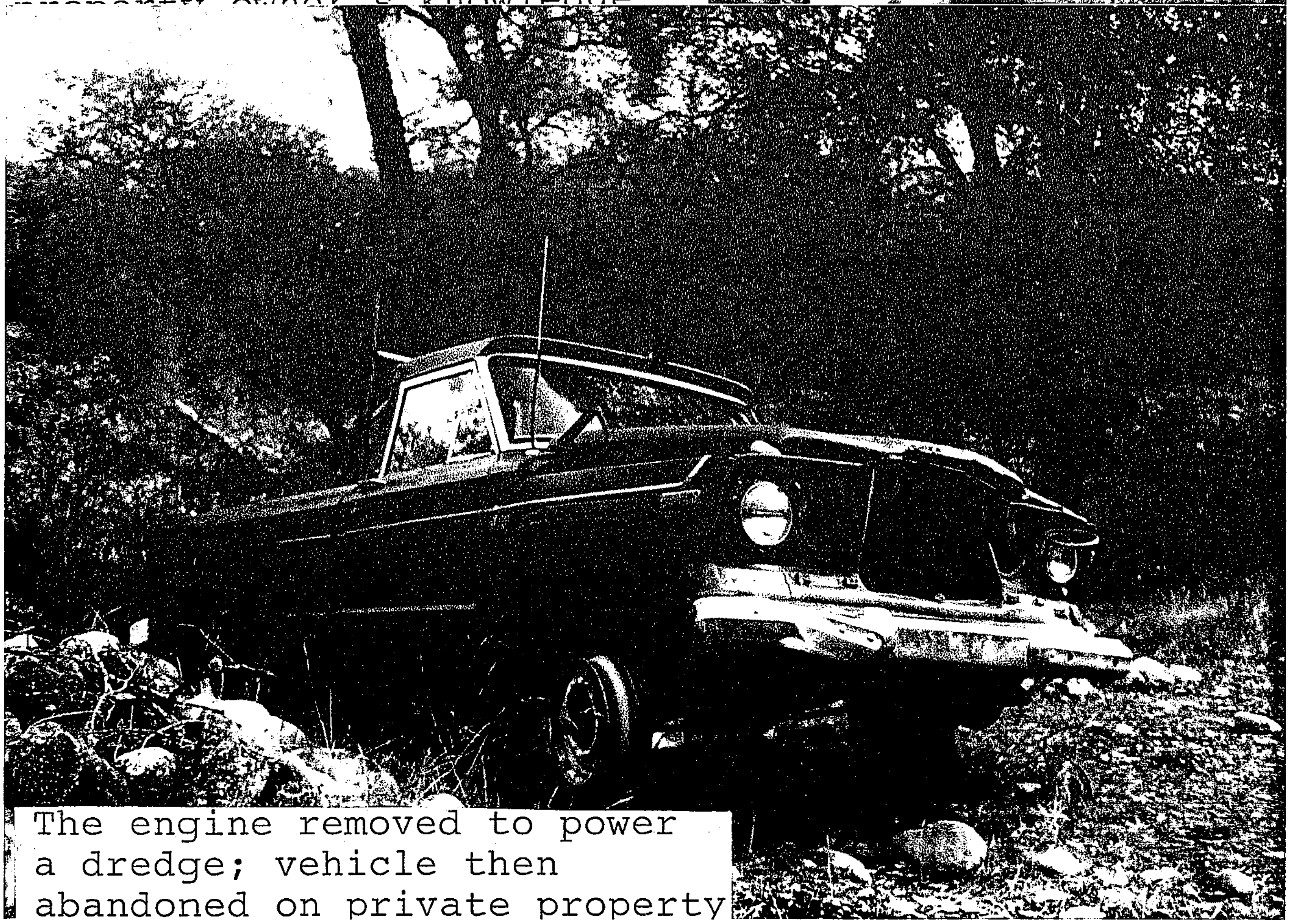
Knowles: "Yeah... Well, you know, you seem to say that since there's interagency cooperation between the local sheriff's departments and so forth, apparently out of the complaints that are made, it probably is a pretty reliable number to go with 500 in ten years -- 50 per year."

Swickert: "It's not. What we respond to are normally those that are complained about by citizens. We get at those first. First we go after those where we think there's a threat to life, which is actually fairly common, and second..."

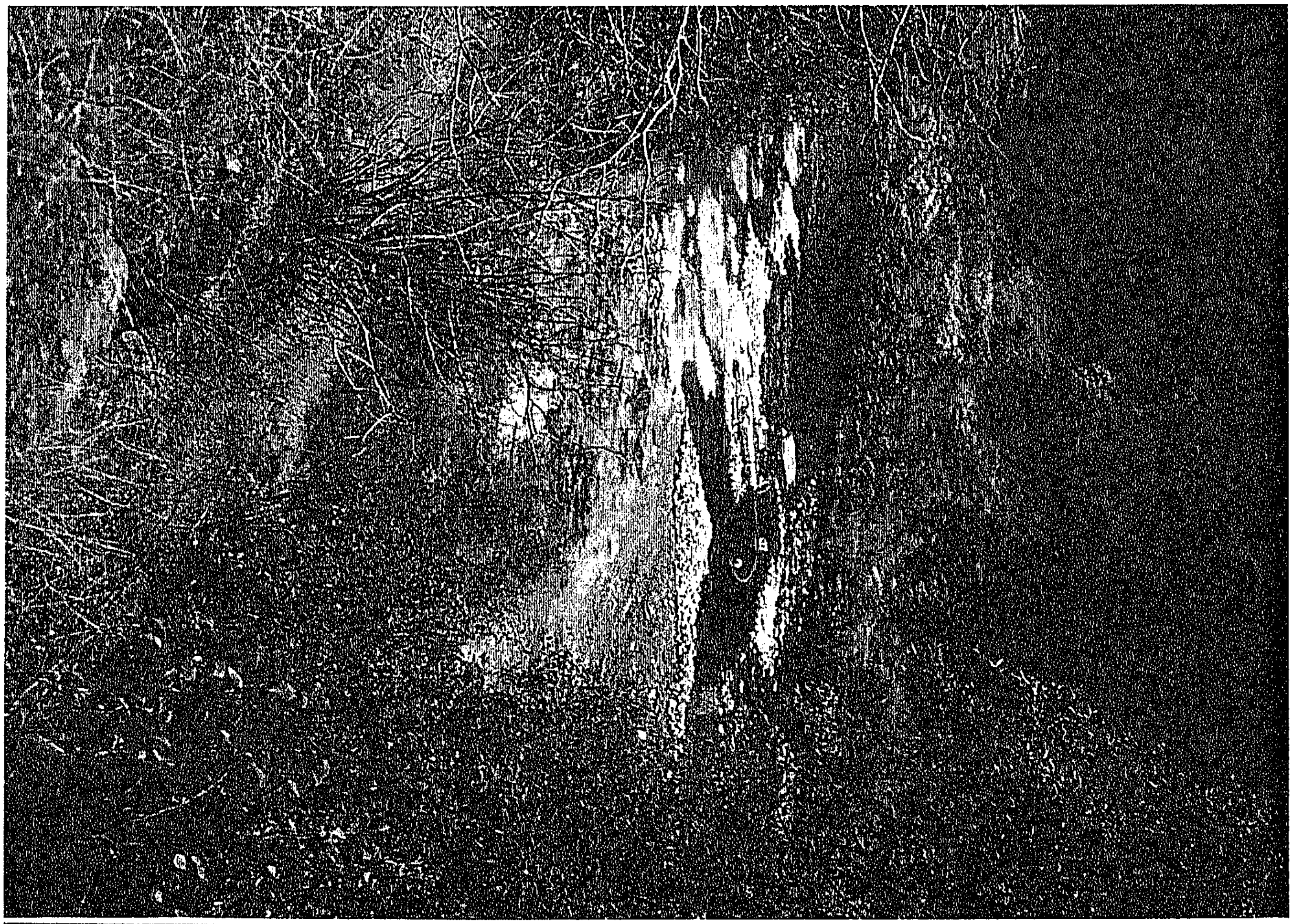
Knowles: "How so? With all the defensiveness and aggression...?"

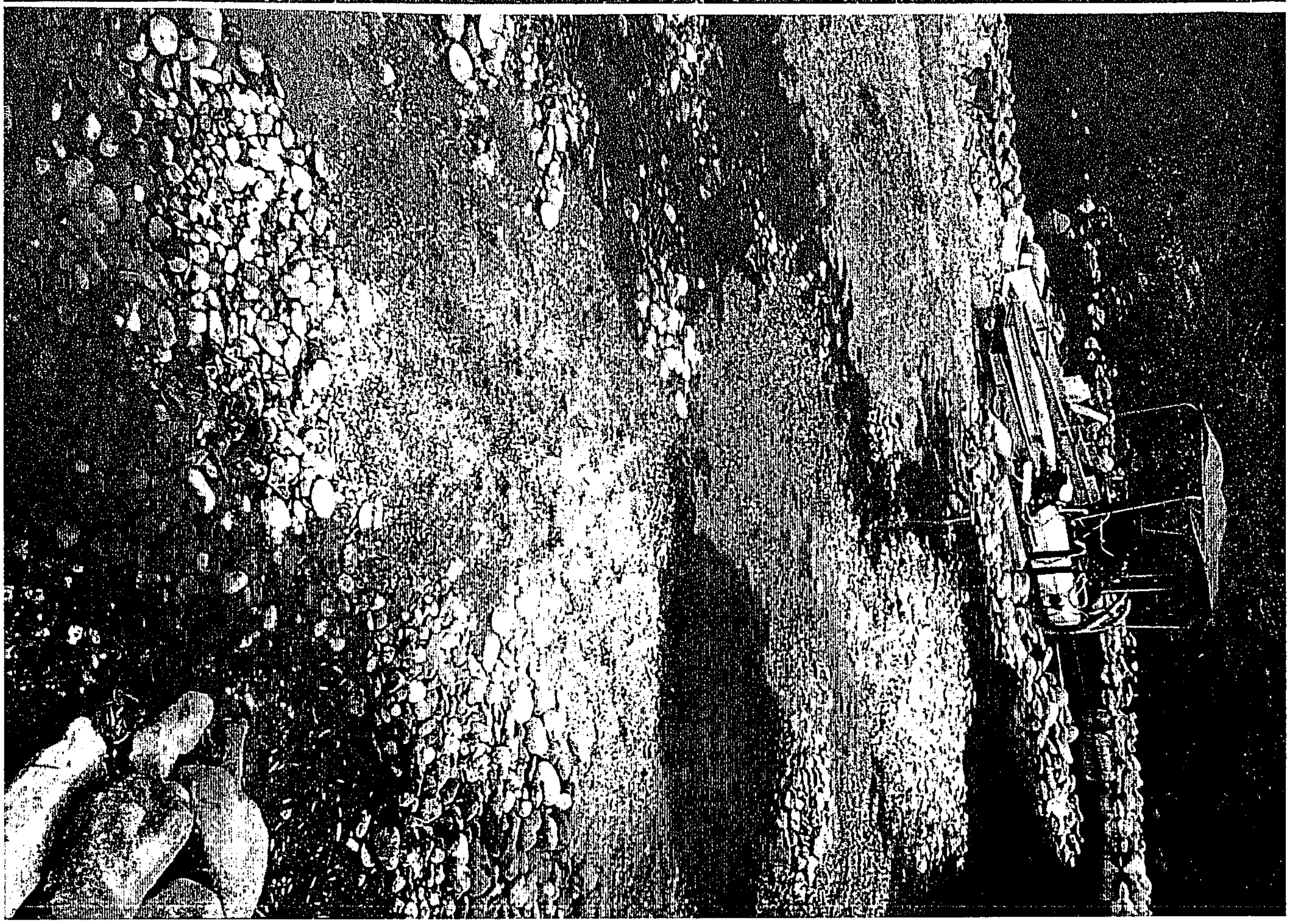
Swickert: "Yes, you see, we've had complaints about weapons being used, and when they escalate, we go in and try to take care of it. And then the second is when there's a real threat to property, and that's when we get complaints about fire and that sort of thing in the summers."

The garbage dump for a dredger camp occupied without property owner's knowledge

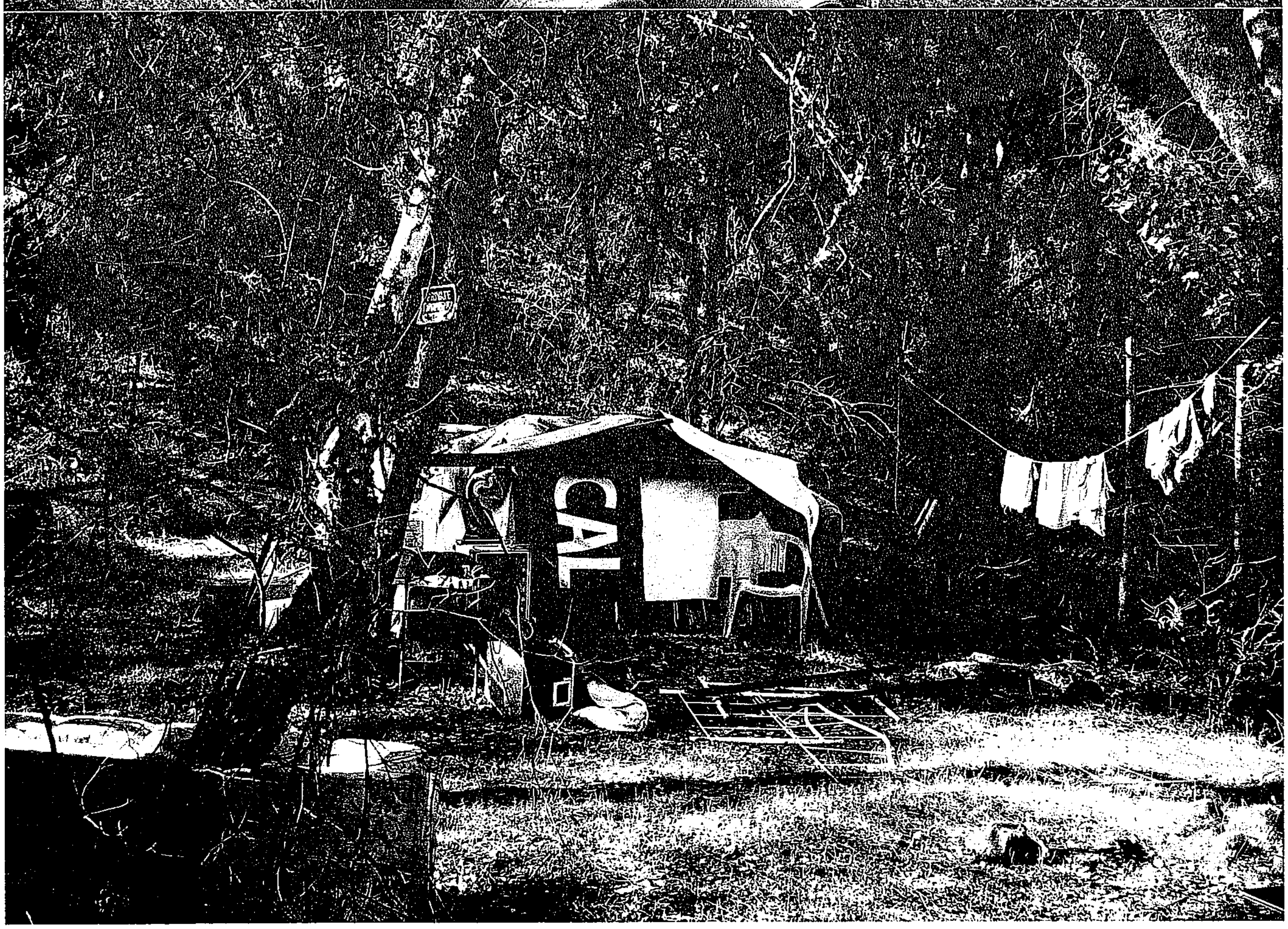


The engine removed to power a dredge; vehicle then abandoned on private property





# Exhibit 16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