State of Nevada
Department of Conservation & Natural Resources

Division of Environmental Protection

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Carson River Mercury Site — Overview

The Carson River basin, from New Empire to Stillwater and the Carson Sink, was designated a National Priority Listed (NPL) site under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund) in August, 1990. This is Nevada's only NPL site and is being jointly managed by NDEP and the U.S. Environmental Protection Agency 9 (EPA), Region IX, in San Francisco.

MERCURY

Mercury is toxic to humans and other organisms. It affects the central nervous system as well as the brain, kidneys and developing fetus. Mercury can also bioaccumulate; that is, increase in concentration through the food chain.

A significant amount of characterization work has been accomplished in the site area to quantify the extent and magnitude of the mercury contamination. This has included the identification of historic mill sites, soil sampling for mercury contamination, development of a health based numerical remediation standard (80 mg/kg total mercury) and an epidemiological survey of the health of residents in the area. The 80 mg/kg level was established by a EPA using a risk assessment methodology for ingestion and is a conservative threshold level for long-term exposure of a child up to 6 years old. The rationale is that children beyond 6 years of age will no longer ingest surface soil incidental in their outside play. Inhalation exposure has been determined to not be a health concern in the area.

The California Pan Mill in Virginia City

HISTORIC MINING — Mining in the Carson River drainage basin commenced in 1850 when placer gold deposits were discovered near Dayton at the mouth of Gold Canyon. Throughout the 1850s, mining consisted of working placer deposits for gold in Gold Canyon and Sixmile Canyon. These ore deposits became known as the Comstock Lode.

Click on the map to see the full Carson River drainage.

The initial ore discovered was extremely rich in gold and silver; gold was more abundant in Gold Canyon while silver was more abundant in Sixmile Canyon. The early mining methods concentrated on exposing as much of the lode as was possible in wide trenches. Throughout 1859, ore was shipped to San Francisco for processing.

After local ore processing began in 1860, most major mining companies operated their own mills, but there were also a large number of smaller private mills. Initial ore processing techniques were slow and inefficient and a fair amount of trial and error experimentation went into the development of an effective ore-processing technique. Refinements were aimed primarily at increasing the speed of gold and silver recovery, increasing the percentage of gold and silver recovered, and decreasing the amount of gold and


The Eureka Mill on the Carson River

silver discarded in tailings piles. The general milling process employed before 1900 involved pulverizing ore with stamp mills, creating a slurry, and adding mercury to the mixture. Mercury forms an amalgam with the precious metals which is then separated from the solution and retorted. After 1900, cyanide leaching and flotation processes replaced amalgamation.

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NEVADA PRIVACY POLICY

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Carson River Mercury Site — Overview

HISTORIC MINING (cont.)

Gold and silver production from the Comstock Lode increased slowly during the early years to 1863, which was the first year of large production. Throughout the remainder of the 1860s and most of the 1870s, production remained high as rich ore bodies continued to be discovered at progressively deeper depths.

Inside the California Pan Mill

The bottom of the lode was abruptly reached in 1877 at a depth of about 1,650 feet, and 1878 was the first year of dramatically reduced production. Between 1877 and 1878, ore production dropped from 562,519 tons to 272,909 tons and the total value decreased from $36,301,536 to $19,661,394. In 1879, production and value dropped even further. In 1901, the first cyanide-leaching operation began in Sixmile Canyon. Cyanide leaching was capable of recovering more gold and silver from lower-grade material than was possible by amalgamation methods, and during the early 1900s mining operations consisted of mining lower-grade material and reworking former ore dumps and tailings piles. Between approximately 1920 and 1950, large tonnages of low-grade ores were mined. Since approximately 1950, mining operations have been extremely limited in scope.

MINING METHODS

The most widely used ore-processing method during the Comstock era was the "Washoe Process". With this process, the raw ore is wet crushed with stamps, the crushed ore is separated from the slurry in a settling tank and then the crushed ore is charged with mercury (approximately 10 percent of the weight of the ore) in the amalgamation pan. The amalgam is separated from the slurry and the silver and gold is separated from the amalgam with a retort. It is thought that the majority of the mercury released to the environment was associated with tailings which were separated from the amalgam slurry and discharged into the drainage. Other possible release mechanisms would have included air emissions from the retort, fugitive air emissions throughout the process, and spilling throughout the process where mercury was handled. It is estimated that the loss of mercury exceeded 1 pound for each ton of ore milled which translates to approximately 14,000,000 pounds of mercury.

The Hale and Norcross Mill in Virginia City

MERCURY AS A CONCERN

Elevated mercury levels in the Carson River drainage basin were discovered in the early 1970s when sampling conducted by the U.S. Geological Survey (USGS) revealed elevated levels in river sediment and unfiltered surface water from the Carson River downstream from pre-1900 ore milling sites. Subsequent studies by a number of investigators have further delineated the extent of mercury in river and lake sediment. Based largely on the information presented in these studies, the Carson River basin below New Empire in Carson City was added to the National Priorities List (NPL) in August, 1990 due to the widespread presence of mercury. Sources of mercury in

the Carson drainage basin and Washoe Valley include mercury imported from the Almaden area of San Jose, California during the Comstock era and, possibly, naturally occurring mercury. There is insufficient information to characterize the full extent and significance of naturally occurring mercury in the Carson drainage basin and Washoe Valley. However, according to reports which characterize the geology of the Carson River drainage basin, naturally occurring deposits of mercury of economic importance do not exist in the basin.

The Mexican Mill in Carson City

The Santiago Mill on the Carson River.

Less significant natural occurrences of mercury can be associated with mineralized zones and hot springs deposits. Although it is possible that there are such natural occurrences of mercury in the region, such sources are not considered important relative to the large amount of mercury imported to the region during the Comstock era.

Mercury imported to the region during the Comstock era was purchased by mills for processing gold and silver ore. These mills employed various processes to amalgamate gold and silver. All of these processes included pulverizing the ore with stamps; creating an amalgam by mixing the crushed ore, salt, and elemental mercury into a slurry; separating the impregnated amalgam; and, finally, separating the gold and silver from the mercury with a retort. It is estimated that 236 such mills operated during the Comstock era (see maps of milling sites; 5mb).

EXPOSURE

Potential migration pathways for mercury through the CRMS include surface water, soil, and air. Transport mechanisms are as follows:

- fluvial (river) transport of mercury laden sediment and soil,
- fluvial (river) transport of dissolved mercury,
- aeolian (air) transport of particulate mercury,
- aeolian (air) transport of volatile mercury, and
- percolation of elemental mercury and/or amalgam.

Fluvial transport is considered the most important mechanism for distributing mercury throughout the Carson Drainage and Washoe Valley. This is because mill tailings are considered the most significant release mechanism and this material is easily transported by fluvial processes. Aeolian (airborne) transport mechanisms may also account for the widespread dispersion of mercury in the region. The fate and transport of gaseous mercury emissions to the atmosphere is not well defined, however, it is believed that gaseous mercury was released to the environment from mills while operating and that mercury evasion is presently occurring. Also included as a transport mechanism is percolation which refers to the vertical movement of mercury through the subsurface. This transport mechanism would account for the vertical movement of elemental mercury or amalgam that was released to the environment.

The Dayton Area

Several historic millsites were located in and around Dayton (see maps of milling sites; 5mb). Because Dayton is located at the mouth of Gold Canyon and on the flood plain of the Carson River, tailings may have been deposited in and around Dayton from other upgradient source areas. Samples were collected from soil, groundwater, air, and domestic produce; and exposure point concentrations were derived. In addition to the Dayton area, soil samples were also collected from Sixmile Canyon, Gold Canyon, the alluvial fan below Sixmile Canyon, the Carson River flood plain, the beach areas of Lahontan Reservoir, Washoe Lake, and Indian Lakes; and exposure point concentrations were derived to represent the level of contamination in these areas. Exposure point concentrations were also derived from muscle tissue from fish and waterfowl using data from Nevada Department of Wildlife, Nevada Division of Environmental Protection, and United States Fish and Wildlife Service.

The Nevada Mill in Virginia City

In the areas where mercury was thought to occur, it was assumed that the highest levels of mercury would occur at and around historic millsites and tailing piles. The basis for this assumption is that there would be minimal dilution caused by transport. Thus, the remedial investigation included an exhaustive research effort to identify the Comstock mills and then map the millsites. Out of this research, the location of 131 mills were identified and the area of these millsites were mapped (although more recent mill site mapping has revealed approximately 236 millsites - see updated maps). At each of the millsites, 5 to 25 surface soil samples were collected to evaluate if levels of mercury, arsenic, and lead were significant. Although subsurface soil was also sampled at millsites, the main objective was to evaluate whether incidental ingestion of surface soil was an exposure pathway of concern at the millsites. Surface soil samples were collected at locations where mercury was thought likely to occur (i.e., tailing piles, tailing ponds, ruins, etc.,).

HEALTH RISKS

The results of this sampling were used to assess the human health risks for the entire study area and establish a mercury action level for surface soil. The site specific action level born out of a risk assessment is **80 mg/kg**. This action level identifies a soil level that would create a dose for a child (age 1 - 6) equivalent to the oral reference dose (RfD) for inorganic mercury. This action level takes into account the species of mercury generally found in the soil matrix and the bioavailability of those species.

Additionally, arsenic and lead were also identified as site Contaminants of Concern (CoCs). These metals may also cause negative health impacts and were found in excess of three times their normal background concentrations.

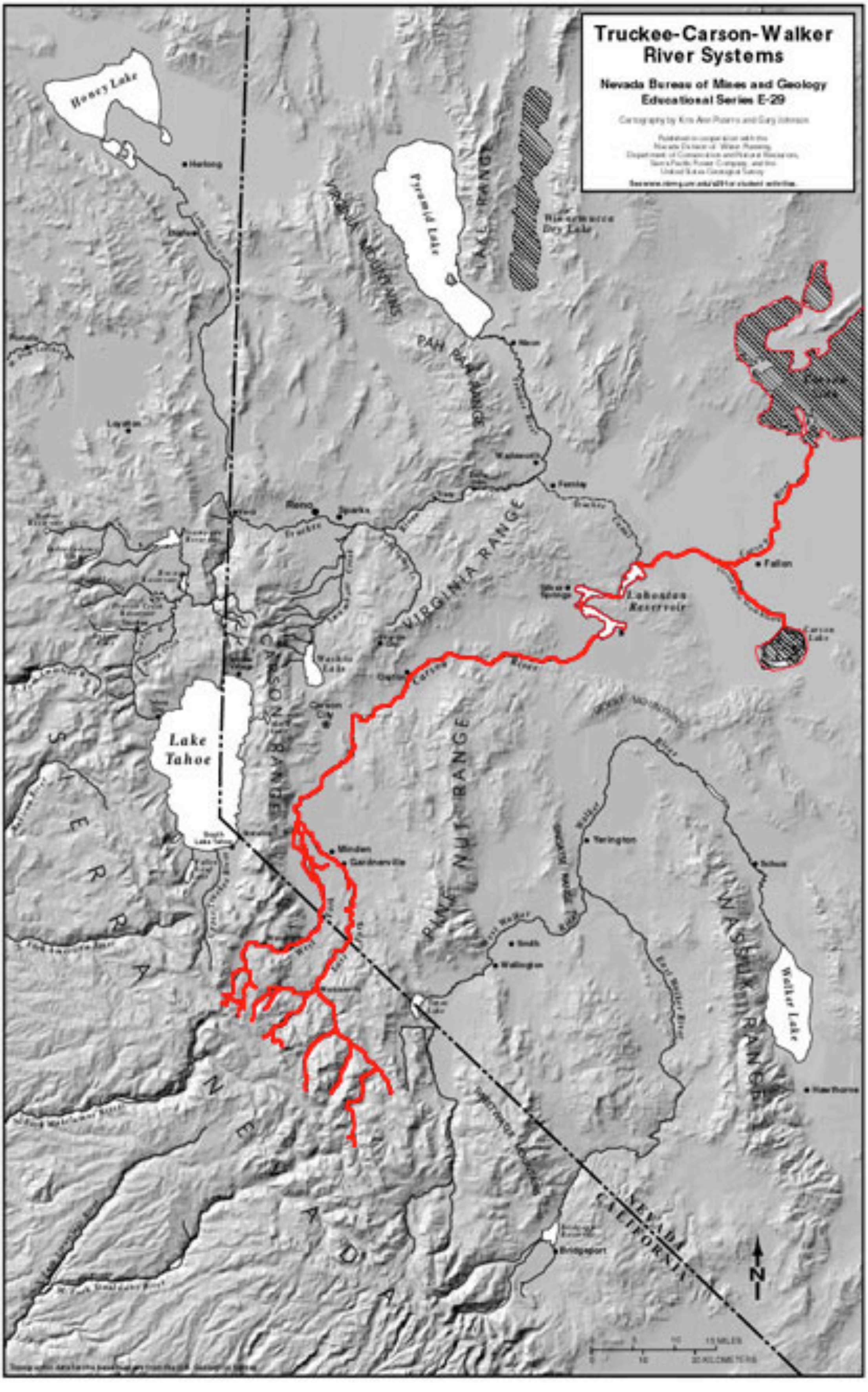
MITIGATION

As a result of EPA's work, six areas in the town of Dayton and one area in Silver City have been identified where mercury-contaminated surface soil removal was necessary. The cleanup included the excavation of contaminated soils to a depth up to two feet, offsite disposal of the soil, replacement of the contaminated soil with clean fill, grading and surface contouring to restore the property to pre-cleanup conditions, and revegetation of the affected areas. EPA and its contractors began their work in August, 1998 and concluded their activity in December, 1999. EPA identified this action as "Operable Unit 1."

The Operable Unit 1 cleanup was carried out in accordance with the March, 1995 EPA Record of Decision for the Carson River Mercury Site; the June, 1996 Remedial Design, and the February, 1997 plans and specifications.

The Operable Unit 1 cleanup dealt only with the identified highly contaminated soils in and around existing residences. Area alluvial fans and the Carson River floodplain have yet to be characterized. Delineation of contamination in these areas could be a monumental task and would be prohibitively expensive. For this additional characterization, EPA, in cooperation with State and local governments, would require the collection of baseline environmental data prior to the development of the land using guidance contained in the Long Term Sampling and Response Plan (LTSRP). The results of these assessments would allow for educated decisions to be made with regard to the need for mitigation and/or cleanup of the site to protect future users of the property.

Operable Unit 2 will address the bed and banks of the river to Lahontan Dam, and the area beyond Lahontan Dam extending to the Carson Sink. Studies on Operable Unit 2 are currently on-going and will include the effects of mercury contamination on the biota and ecosystem in the Carson River basin. Included in these studies are the plants, fish and birds native to Lahontan Dam, and migratory bird populations that pass through the area on an annual basis.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