Record of Decision
Old/No. 8 Seep
Iron Mountain Mine
Shasta County, California

September 24, 1993

U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

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RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECLARATION

I. SITE NAME AND LOCATION

Iron Mountain Mine
Shasta County, California (near Redding, California)

II. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial action for control of heavy-metal-bearing acidic discharges, termed acid mine drainage, or AMD, from the Old and No. 8 Mines into Slickrock Creek. These discharges are the third largest source of AMD at the Iron Mountain Mine Superfund Site. Slickrock Creek is a tributary of Spring Creek, which in turn is a tributary of the Sacramento River. Slickrock Creek is on the south side of the Iron Mountain Mine (IMM) site. The IMM site is located about 9 miles northwest of Redding, California.

The selected interim remedial action is to collect and treat the AMD from Old/No. 8 Mine Seep. The selected interim remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based upon the administrative record for this site.

The Natural Resource Trustees Council, which includes both State and Federal resource trustees for the Site, concurs with the selection of treatment and the High Density Sludge (HDS) process option as the interim remedial action for the Old/No. 8 Mine Seep acid mine drainage discharges.

The California Department of Toxic Substances Control (DTSC) and Regional Water Quality Control Board (RWQCB) concur with the selection of lime treatment and use of a process option that will produce a dense sludge as the interim remedial action for the Old/No. 8 Mine Seep acid mine drainage discharges. However, DTSC and RWQCB have encouraged EPA to fully evaluate the Aerated Simple Mix (ASM) process proposed by Stauffer Management Company (SMC) as an alternative to the HDS process. EPA has reviewed recently available treatability study data that indicate that the ASM process will not produce the required dense sludges that DTSC and RWQCB agree are necessary. EPA will review this information with the DTSC and RWQCB and will continue to assess any subsequently developed information.

III. ASSESSMENT OF THE SITE

Heavy-metal-laden AMD is released from several, and possibly all, of the inactive mine workings at IMM and from the numerous waste piles on the mine property. The AMD drainage discharges to surface waters (which include Boulder, Slickrock, and Spring Creeks, the Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River), causing severe environmental impacts and posing a potential threat to human health. The Sacramento River is a major fishery and source of drinking water for Redding. The National Oceanic and Atmospheric Administration (NOAA) has identified the affected area as the most important salmon habitat in California. Under the Clean Water Act §304(l) inventory of impaired water bodies and the toxic point sources affecting the water bodies, EPA identified the IMM site as the largest such discharger of toxic metals in the United States.

EPA has identified control of AMD sources in the Old/No. 8 Mine Seep Operable Unit as a major step in the ultimate control of discharges of contamination from the IMM site. The Old/No. 8 Mine Seep is the third largest source of AMD at the site. Actual or threatened releases of AMD from this site, if not addressed by implementing the response action selected in the Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

The Old/No. 8 Mine Seep Operable Unit (OU) includes the AMD discharges from the seeps which emerge from the north slope of the Slickrock Creek valley in the vicinity of several portals of the Old Mine and No. 8 Mine. The mine portals are covered by landslides, and the mines are not accessible.

The AMD discharged to Slickrock Creek contains high concentrations of copper, cadmium, and zinc and is the primary exposure pathway. The principal threat posed by these releases is the creation of conditions toxic to aquatic life in the receiving waters, most importantly, the Sacramento River. The Sacramento River supports a valuable fishery that includes four species of chinook salmon, steelhead, and resident trout. The Winter-Run Chinook Salmon has been designated as a threatened species under the Endangered Species Act.

The ROD for the Old/No. 8 Mine Seep Operable Unit (OU) is the third ROD for the IMM site. The first ROD for the Site, signed in October 1986, provided limited source control actions to begin lessening the AMD discharges and provided water management capability to manage the ongoing AMD releases to surface waters. Specific activities authorized by the 1986 ROD include a diversion of Slickrock Creek around sulfide-bearing landslide debris, diversion of Upper Spring Creek in the Boulder Creek drainage, and a partial cap of Brick Flat Pit. All of these projects have been completed. The 1986 ROD also authorized the enlargement of the Spring Creek Debris Dam and the diversion of the South Fork of Spring Creek. The enlargement of Spring Creek Diversion Dam is currently being designed by the U.S. Bureau of Reclamation under an agreement with EPA.

The second ROD for the IMM site was signed on September 30, 1992. It provided for an interim remedial action to treat AMD from the Richmond portal and the Lawson portal in the Boulder Creek Operable Unit. This action addressed the two largest sources of heavy-metal-laden AMD at the site. The design of the AMD collection and conveyance system, the treatment system, and the sludge disposal in Brick Flat Pit is underway.

To achieve the remedial action objectives of the Superfund action at the IMM site, EPA expects to require a further study or studies for the sources in the Slickrock Creek drainage not addressed in today's Record of Decision; other sources in the Boulder Creek drainage; sediments in Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River; contaminated groundwater; and other sources of contamination. The additional study will also assess potential water management options, including the need to coordinate releases of acidic waters with Central Valley Project water releases. Any further study will also consider resource recovery and source control. EPA is currently developing a work plan for this additional Remedial Action/Feasibility Study (RI/FS) activity, and this study will consider achieving all Applicable, or Relevant, and Appropriate Requirements (ARARs) for the actions.

IV. DESCRIPTION OF THE SELECTED REMEDY

The remedy selected in this decision document addresses the principal threat posed by contaminant releases from sources within the Slickrock Creek watershed at the IMM site through collecting and treating the Old/No. 8 Mine Seep discharge.

The major components of the selected remedy include:

- Construction of necessary structures, pipelines, pumping stations, and equalization to provide for delivery of all AMD flows from the Old/No. 8 Mine Seep to the treatment facility.
- Treatment facilities to perform chemical neutralization/precipitation treatment of all of the Old/No. 8 Mine Seep AMD using the lime high density sludge (HDS)/simple mix treatment process option to meet the performance standards of 40 C.F.R. Part 440, which have been determined to be relevant and appropriate to this application. Discharges to lower Spring Creek, Boulder Creek, and Slickrock Creek shall comply with the effluent limitations of 40 C.F.R. §§440.102(a) and 440.103(a), except for the limitation on pH and total suspended solids (TSS). Discharges to Flat Creek shall also comply with the pH and TSS requirements of 40 C.F.R. §440.102(a).
- Disposal of treatment residuals onsite in the inactive open pit mine, Brick Flat Pit. The design of the improvements to Brick Flat Pit to function as a disposal facility shall comply with the requirements of the Toxic Pits Control Act and California requirements for disposal of mining wastes.

V. STATUTORY DETERMINATIONS

This interim action is protective of human health and the environment. The selected remedy essentially eliminates the potential exposure and the resultant threats to human health and the environment from the sources and pathways addressed in this interim action. The Old/No. 8 Mine Seep Operable Unit provides for an interim action that is not expected to be final and does not address all of the sources of discharges from the IMM site. The selected remedy, therefore, cannot be expected to be fully protective of human health and the environment. Further remedial actions are required.

This interim action complies with (or waives) Federal and State ARARs for this limited-scope action. The selected remedy is expected to comply with most chemical-, action-, and location-specific ARARs. Because of the environmental impacts of the sources not addressed in this ROD, EPA anticipates that the Old/No. 8 Mine Seep Operable Unit remedial action will not provide for compliance with all ARARs at all times, and consequently EPA is relying on the ARARs waiver for "interim measures" (40 C.F.R. §300.430(f)(1)(ii)(C)(1)) for remedy selection with respect to sources in the Old/No. 8 Mine Seep Operable Unit. The selected remedy does not address all sources of contaminant discharges at the site and cannot provide for compliance with the chemical-specific ARARs of the Central Valley Regional Water Quality Control Board's Basin Plan water quality objectives at all times or for full compliance with California Fish and Game Code Section 5650, which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life." Accordingly, EPA is invoking the CERCLA Section 121(d)(4)(A) waiver for "interim measures" for these ARARs.

EPA has determined that the selected remedy is cost-effective pursuant to evaluations in accordance with Section 300.430(f)(1)(ii)(D) of the NCP. EPA has considered the quality of the data relied upon to characterize the site and the Old/No. 8 Mine Seep discharge. EPA has also considered the quality of the data relied upon during the development and evaluation of potential remedial alternatives, and the selection of the interim remedial action for the Old/Mine 8 Mine Seep.

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized for the interim remedial action for the Old/No. 8 Mine Seep Operable Unit at the IMM site. Alternatives that might reduce or eliminate the AMD-forming reactions have been developed and evaluated in the Boulder Creek Operable Unit. EPA has concluded that significant additional development and evaluation of these approaches is required, and this conclusion also applies to the Old/No. 8 Mine Seep Operable Unit. EPA encourages the continued development of those alternatives that could reduce or eliminate the AMD-forming reactions for consideration in a subsequent action for the IMM site. Treatment of the discharges will effectively eliminate the contaminant discharges and is a component of all alternatives developed to date. Treatment, therefore, is consistent with any anticipated subsequent actions.

Because this action does not constitute the final remedy for the IMM site, the statutory preference for remedies employing treatment that reduces toxicity, mobility, or volume as a principal element will be further addressed by the final response action. Subsequent actions are planned to fully address the threats posed by the conditions at this site. Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within 5 years after commencement of the remedial action. Because this is an interim action ROD, review of this site and of this remedy will be ongoing as EPA continues to develop final remedial alternatives for the site.

Nora L. McGee for
John Wise
Acting Regional Administrator

9-24-93
Date

RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

I.1 Site Name

Iron Mountain is located in Shasta County, California, approximately 9 miles northwest of the City of Redding, see Figure 1. The collection of mines on Iron Mountain is known today as Iron Mountain Mines. They are the southernmost mines in the West Shasta Mining District. The District encompasses over a dozen sulfide mines that have been worked for silver, gold, copper, zinc, and pyrite.

I.2 Site Location

The Iron Mountain Mine Superfund site is defined pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to include the inactive mines on Iron Mountain and areas where hazardous substances released from the mines are now located. The Iron Mountain Mine (IMM) site includes approximately 4,400 acres of land that includes the mining property on the topographic feature known as Iron Mountain, the several inactive underground and open pit mines, numerous waste piles, abandoned mining facilities, mine drainage treatment facilities, and the downstream reaches of Boulder Creek, Slickrock Creek, Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River affected by drainage from Iron Mountain Mine.

I.3 Site Description

The summit of Iron Mountain is 3,583 feet above mean sea level and is approximately 3,000 feet above the Sacramento River, 3 miles to the east. The terrain is very steep, with slopes dropping 1 to 2 feet for every 2 feet horizontally, or steeper. The mountain is predominantly forested with some areas of brush, and there are numerous unpaved roads leading to various work locations.

Several, and possibly all, of the mines and the waste rock piles are discharging acidic waters, typically with a high content of heavy metals. These discharges are herein referred to collectively as acid mine drainage, or AMD. The largest sources of AMD are located within the Iron Mountain Mine property. The largest source of AMD is the Richmond Mine, and the second largest is the Hornet Mine, both of which drain into Boulder Creek. The third largest source and the subject of this ROD is the Old/No. 8 Mine Seep, which drains into Slickrock Creek. Old/No. 8 Mine Seep is

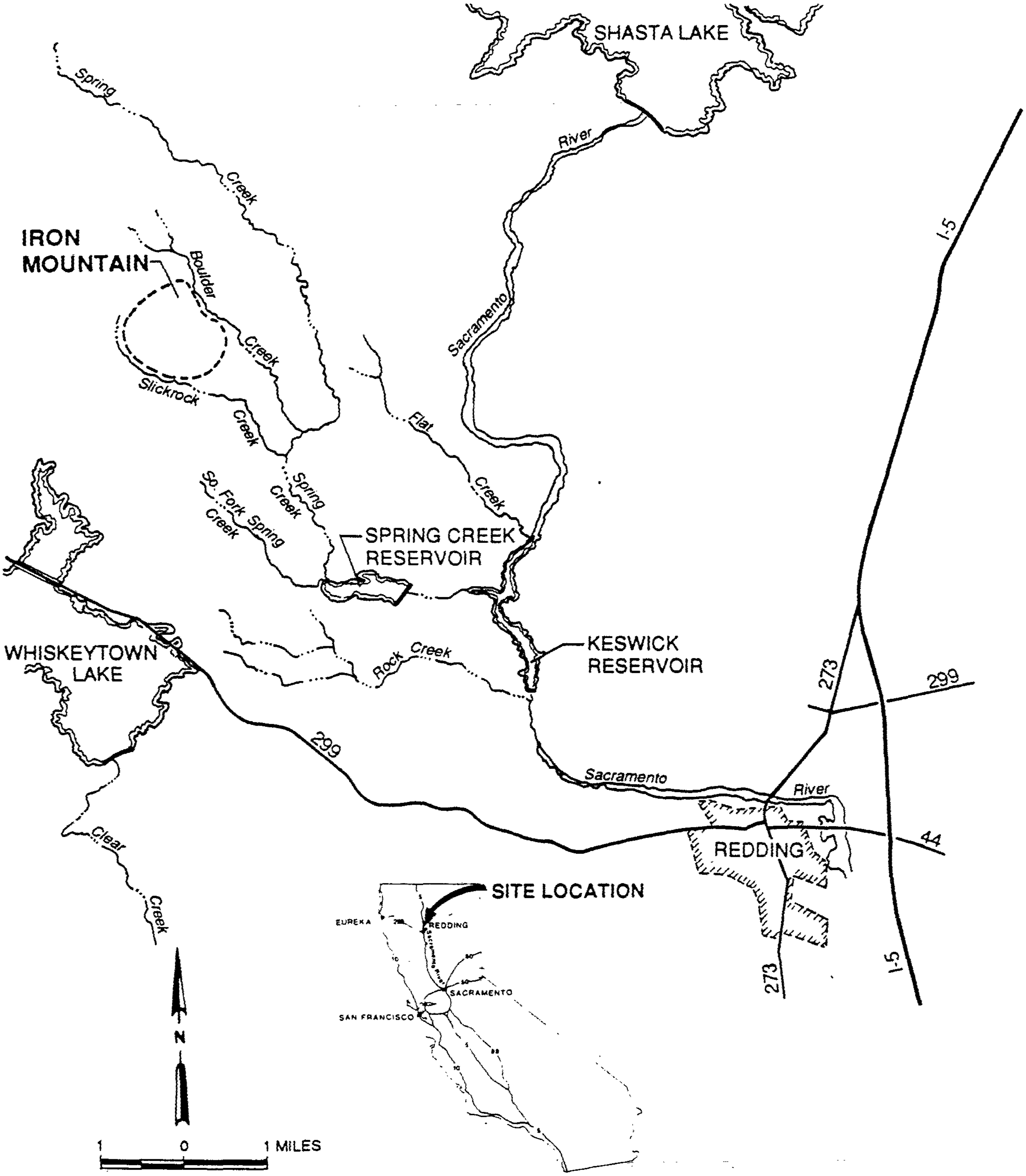

FIGURE 1
LOCATION OF
IRON MOUNTAIN SITE
IRON MOUNTAIN MINE OLD/NO. 8 MINE SEEP ROD

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AUGUST 1993
RDD69205.05.01

located on the south side of Iron Mountain at an elevation of approximately 2,500 feet. The seep is located on the north slope of the Slickrock Creek valley proximate and below the landslide-covered portals of Old Mine and No. 8 Mine. The portals were covered when a large mass of overburden soils and waste rock (largely from the Brick Flat Pit open pit mining) slid into Slickrock Valley in 1955. The frequent small slides are continuing to add to the landslide cover. The present condition of the tunnels and stopes of the Old Mine and No. 8 Mine is unknown, but the available reports and literature indicate that some of the mine openings were backfilled with sludge and waste rock during mine operations. From observations of other underground mines at this site, it is reasonable to assume that some of the unfilled mine openings have collapsed. The proportion of drainage from the two mines is unknown.

EPA has identified control of the AMD sources in the Slickrock Creek drainage basin as a major step in the ultimate control of the contaminant discharges from Iron Mountain. EPA has designated the Old/No. 8 Mine Seep as an Operable Unit for a feasibility study of pollution sources and alternative approaches for AMD control.

The IMM site contains a very large mass of nearly pure sulfide (massive deposit), several small massive sulfide deposits, several zones of disseminated sulfides, and a large gossan. The gossan is a zone of rock from which disseminated sulfides have been almost completely removed by natural solution, leaving a residue of iron and other metals. The gossan has been mined by open pit for residual metals. The disseminated and massive sulfides have been mined in open pit and underground openings for copper, cadmium, zinc, and pyrite. The main country rock at the IMM site is rhyolite.

Commercial mining at the IMM site started in 1879 and continued, with a few interruptions, until 1963. In the early twentieth century, the site was one of the largest copper mines in the United States. Mineral extraction objectives and methods varied widely. In recent years, metal recovery activity at the site has been limited to extracting copper from the AMD, using copper cementation and occasional sales of previously mined material (such as hematite tailings).

I.4 Adjacent Land Uses

The adjacent land is largely undeveloped wilderness property that is currently infrequently visited because of the rugged topography and few roads. Off-road vehicles have been known to visit these areas, and the U.S. Bureau of Land Management has notified EPA with regard to potential acquisition of adjacent lands for preservation as wilderness and enhancement for recreational use.

I.5 Natural Resources Uses

The natural resources on the mining property and in the surface waters which flow on or adjacent to the mining property at one time included mature stands of timber, fish, other aquatic populations, and sulfide minerals. The natural resources in the down-gradient Sacramento River include the valuable Sacramento River fishery, recreational use of the river and Keswick Reservoir, and the valuable water resources, which are a major component of the U.S. Bureau of Reclamation's (USBR's) water distribution system for the State of California.

The timber on the IMM site has been largely removed for the mine operations or sale. The timber stands were also extensively damaged by historic smelter operations in the early 1900s. The portions of Boulder Creek, Slickrock Creek, and Spring Creek impacted by AMD from IMM are essentially lifeless. A major portion of the sulfide minerals remain in the mines and in undeveloped areas. The market for sulfide minerals has not been attractive in recent years, and there is no verified proposal to mine these deposits in the near future.

Spring Creek Reservoir was constructed in part as a mitigation measure for the AMD discharges and does not support aquatic life. It is not used for any recreational purpose.

The portion of Keswick Reservoir impacted by Iron Mountain Mine AMD has reduced recreational value. The resident trout fishery is impacted by the heavy metal contaminants in the water column of the mixing zones and the heavy sediment loadings caused by the precipitation of iron and co-precipitation of heavy metals.

The upper Sacramento River salmon fishery is the most important fishery in the State. The salmon fishery has experienced large population declines over the past 20 years because of a number of factors, including Iron Mountain Mine AMD impacts. The Sacramento River also supports a major steelhead trout and resident trout fishery.

The water resources held in Shasta Lake by the USBR as part of its Central Valley Project (CVP) are an important component of the water distribution system for a growing California's municipal and agricultural interests. CVP operations are today sometimes constrained by the Iron Mountain Mine AMD discharges in order that water quality conditions in the Sacramento River can be maintained within safe bounds for fishery protection. On occasion, USBR has released water from Shasta to dilute AMD, water which would otherwise have been used for beneficial purposes.

I.6 Location and Distance of Human Populations

Iron Mountain Mine is mainly remote from human populations because of the rugged terrain and the single-access roadway. The mine owner has provided heavy metal gates, which are locked at most times to discourage casual entry to the site. Human contact with the flows from Iron Mountain is mainly limited to the waters downstream of Spring Creek Debris Dam, which include Keswick Reservoir and the Sacramento River below Keswick Dam.

The closest community is Keswick, located just east of the site. Several isolated residences are between Keswick and the mine property. The City of Redding has a population of approximately 70,000 people and is located approximately 9 miles from the site.

I.7 General Surface-Water and Groundwater Resources

Local surface drainage includes Boulder Creek, located northeast of the mountain, and Slickrock Creek, located to the southwest. Boulder Creek and Slickrock Creek flow into Spring Creek. Spring Creek flows south and east to the Spring Creek Debris Dam (SCDD), from which the USBR releases flow into the Sacramento River. Flat Creek drains an area to the east of Iron Mountain and enters the Sacramento River approximately 0.8 mile north of Spring Creek. Flat Creek also receives water from Upper Spring Creek, as a result of a water diversion project constructed in 1990 as part of the CERCLA response at Iron Mountain.

Old/No. 8 Mine Seep consists of several apparently separate discharges in an area of about 130 square feet. The AMD discharging from the seep flows downhill and is collected in an unlined basin about 12 feet long, 10 feet wide, and 2 feet deep. The basin was constructed to measure flows from the seep. The AMD flows from the basin to a copper cementation plant in a 140-foot-long stainless steel flume.

Slickrock Creek drains the south side of Iron Mountain and flows generally from the northwest to the southeast. The headwaters of Slickrock Creek are at about Elevation 3200 feet. The creek flows about 3 miles to its confluence with Spring Creek at Elevation 1350. The stream carries water from several small ephemeral tributaries as well as discharges from Old/No. 8 Mine Seep and Big Seep, 200 to 300 feet upstream. Slickrock Creek also receives drainage from Brick Flat Pit. The average daily flow of Slickrock Creek at its confluence with Spring Creek is 9.4 cubic feet per second (4,200 gpm).

The rainfall-runoff responsiveness of the Old/No. 8 Mine Seep Operable Unit may vary significantly throughout storm events. The amount of runoff is dependent on antecedent moisture conditions, storm intensity, the vegetative cover, ground slope, length of distributing area, and geology. Major storm events may cause a rapid rise in water levels in the creek.

The rhyolite country rock is a dense rock with two to three sets of joints and a number of faults. The rock blocks generally lack significant porosity, and the low porosity of the rock mass is due to the joint/fault discontinuities. The presence of groundwater and its movement within the rock are largely controlled by the discontinuities.

The massive sulfide deposits were largely isolated from the groundwater before mining because the joints generally do not extend from the country rock into the mineralized zone. Groundwater was present in the disseminated zones. Mine openings and cracking caused by ground movements induced by mining have opened large volumes of massive sulfide to groundwater and have increased groundwater access to the disseminated sulfide mineralization. The additional groundwater movement and increased circulation of air within the rock mass has greatly accelerated the process of sulfide dissolution and the formation of metal-rich acid mine drainage.

Surface water and groundwater at Iron Mountain were previously used for mining operations and to provide water supply to the mine staff and their families. These resources are essentially unused today because the mines are inactive and surface waters are being contaminated by AMD.

I.8 Surface and Subsurface Features

An open pit mine at Brick Flat, underground workings at Old Mine, No. 8 Mine, the Confidence-Complex Mine on the southern flank of the mountain, and the Richmond and Hornet Mines on the northern flank are the large mines on Iron Mountain.

Four sulfide ore bodies were mined in the Slickrock Creek drainage. They are Old Mine, No. 8 Mine, Confidence Mine, and Oskosh Mine. The Oskosh is a small mine on the south side of the Slickrock Creek valley at a relatively low level, and the Confidence Mine is high on the north side of the valley. Both mines appear to discharge small to moderate volumes of AMD or secondary quantities of metal. The Old Mine and No. 8 Mine appear to have had more significant mining operations and to be more significant sources of AMD.

Old Mine was developed to mine portions of a gossan deposit which could not be reached by quarrying. The mine is under the north slope of Slickrock Creek valley with the mine workings ranging from the elevation of the lower slope to well below the elevation of the adjacent reach of Slickrock Creek. A method of underground mining called slice stoping was used. The ore was removed in 7-foot-high layers working from the bottom toward the top of the deposit. A working surface was maintained by progressively backfilling the mined opening with rock rubble returned to the mine through dropholes from the ground surface. The extent of the backfilling is not clear from the records available to EPA, but the volume of remaining voids in the mine at the time of closure may have been small compared with adjacent mines on the IMM site.

The ore deposit of the No. 8 Mine is at the level of the middle of the north slope of Slickrock Creek valley. The intervening 300 feet of rock has little or no sulfide mineralization. The ore is a mass of rock with disseminated chalcopyrite mineralization in veins as contrasted with the massive sulfide or massive disseminated ore bodies of the other mines on the IMM site. The mine consists of three levels of tunnels and small to moderate size openings which follow the veins. The mine is as high as Elevation 2400, but portions are below the elevation of Slickrock Creek. Mining started in 1907 and ended after World War II. Portions of the mine are reported to have been backfilled with waste rock or tailings slime.

The Brick Flat open pit mine was operated between 1929 and 1942 and from 1955 to 1962. Most of the overburden and waste rock was placed in a large waste pile south of the pit and above the north slope of Slickrock Creek valley. In 1955, a large landslide of these materials moved into the Slickrock Creek valley, covered the Old Mine and No. 8 Mine portals, and filled the valley bottom to a depth of 80 feet. A comparison of old and recent topographic maps indicates that the present bed of Slickrock Creek is about 40 feet south of the bed prior to the large slide. The slide surface is presently almost devoid of vegetation, suggesting continued sliding.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

II.1 History of Site Activities that Led to Current Problem

Iron Mountain Mine was first secured for mining purposes in 1865 and various individuals held the property and conducted limited mining for the recovery of silver from the gossan cap in the late 1800s. The waste-generating activities that created the surface sources of AMD likely began in the 1880s when the gossan was first mined on a large scale, and waste rock that was removed to reach the ore was apparently dumped into ravines and eventually washed into the creeks.

Beginning in late 1894, Mountain Mining Co., Ltd., began operation of the mine. In approximately 1896, Mountain Copper Co., Ltd., assumed ownership of the mine. Under Mountain Copper, Ltd.'s, operation of the mines, Iron Mountain became the largest producer of copper in California and the sixth largest producer in the country during the first quarter of the twentieth century. The high-grade copper ore in Old Mine was mined until 1907, No. 8 mine from 1907 until as late as 1923, Hornet Mine from 1907 to 1926, the Richmond Mine from 1926 through 1956, and Brick Flat Pit from 1929 to 1942 and 1955 to 1962.

In 1968, Stauffer Chemical Co. acquired Mountain Copper Co., Ltd., and thereby acquired beneficial ownership of the Iron Mountain Mine. Stauffer transferred record of ownership of most of the parcels comprising Iron Mountain Mine from its wholly owned subsidiary to itself in 1969. Stauffer operated the copper cementation plant during its ownership of the site and continued to investigate the commercial mining potential of the property. In November 1976, the California Regional Water Quality Control Board issued Stauffer an order requiring the abatement of the continuing pollution from the mountain.

In December 1976, Stauffer transferred ownership of 31 parcels on Iron Mountain to Iron Mountain Mines, Inc., (IMMI), and in December 1980, 5 additional parcels were transferred to IMMI. IMMI, a California corporation, is the current owner of Iron Mountain. IMMI constructed a copper cementation plant on Slickrock Creek in 1977. IMMI has intermittently operated this plant and the copper cementation plant on Boulder Creek to recover copper from the AMD.

II.2 Impacts of Mining Activity at Iron Mountain

Mountain Copper employed stoping, block caving, and room-and-pillar techniques in the underground mines; side-hill and open-pit techniques were used at the ground surface. These mining activities and subsequent collapse of some of the underground mine workings have fractured the bedrock overlying the mine. The sulfides in the fractured bedrock above the mine and the sulfides remaining in the mine are, in the post-mining period, more exposed to water, air, and bacterial action. The potential for acid drainage and metals contamination is greater than prior to mining and may have increased since the mining ceased in response to deterioration of the ground over the abandoned mines.

The mined openings and the ground affected by mining activity now function as effective groundwater drains, drawing groundwater and unsaturated percolation to and through the sulfide mineralization. The sulfides that were once largely below the water table are now largely within the unsaturated zone, and oxygen is available for reaction. The exothermic oxidation of the sulfide elevates the overall temperature in the sulfide mineralized zone, induces convective airflow, and likely induces evaporation of some subsurface mine waters. These processes contribute to the intensity and pattern of acidic discharges.

These mining-related characteristics, in combination with the natural occurrence at Iron Mountain of nearly pure massive sulfide deposits surrounded by bedrock with very little neutralizing capacity, result in a unique hydrogeochemical reactor that is nearly optimal for maximum production of acid mine waters (Nordstrom and Alpers, 1990). Iron Mountain produces mine waters that are among the most acidic in the world, containing extremely elevated concentrations of copper, cadmium, zinc, and other metals known to be toxic to aquatic life.

II.3 Central Valley Project Related Impacts

The use of Sacramento River water to serve a growing California has also increased the significance of Iron Mountain AMD impacts in the Sacramento River. The USBR constructed Shasta Dam in 1943 to control Sacramento River flows; Keswick Dam, located downstream of Shasta Dam, was completed in 1950. Spring Creek and Sacramento River flows mix in the lower third of Keswick Reservoir. Prior to the USBR's construction of these dams on the Sacramento River, the AMD was often diluted by large flows of water from farther upstream on the Sacramento River.

Although fish kills and toxicity problems were documented prior to the completion of Shasta Dam in 1943, the dam compounded the toxicity problems by reducing the availability of dilution flows (Central Valley Regional Water Quality Control Board, 1976; Wilson, 1977; Finlayson and Wilson, 1989).

Keswick Dam and Reservoir were completed in 1950. This dam restricted the salmon and steelhead to spawning grounds in downstream areas. This restricted the naturally spawning salmon and their early life stages to that area of the Sacramento River with the greatest exposure to AMD discharges from Iron Mountain.

After construction of Keswick Dam in 1950, the sediment load from Spring Creek, which previously had been wasted downstream, caused a delta to form in the Spring Creek arm of Keswick Reservoir.

In response to the problems at Spring Creek, the USBR constructed SCDD in 1963 to help control the toxic releases from Spring Creek and to prevent sediment from forming a delta in the vicinity of the Spring Creek Powerplant tailrace.

The SCDD allows for the storage and controlled release of water from the Spring Creek basin. Optimally, releases from Spring Creek Reservoir are timed to coincide with releases from Shasta Reservoir to meet interim water quality criteria in the

Sacramento River. However, because of the relatively limited capacity of Spring Creek Reservoir with respect to peak discharges from the Spring Creek watershed, there have been uncontrolled spills from the reservoir. Although the debris dam has helped to reduce the incidence and severity of major fish kills, it has not eliminated them. In addition, the gradual release of Iron Mountain AMD from SCDD increases the duration of exposure of fish in the Sacramento River to chronic toxicity resulting from Iron Mountain AMD (U.S. EPA, 1992b).

II.4 History of Federal and State Site Investigations

Remedial investigation (RI) activities at Iron Mountain began in September 1983, when Iron Mountain was placed on the National Priorities List of the nation's most contaminated sites. In conjunction with EPA's Record of Decision for the first operable unit at Iron Mountain, EPA issued an RI report in 1985 (U.S. EPA, 1985a). That report characterizes the entire Iron Mountain site with respect to the nature and extent of contamination from information available at that time. Site characterization studies have continued within the Boulder Creek watershed, and EPA has prepared a second RI report (U.S. EPA, 1992a) to present information developed in these additional studies. An Endangerment Assessment (EA) has been prepared to characterize and evaluate the current and potential threats to the environment that may be posed by Iron Mountain contaminants migrating to the groundwater, surface water, and air (U.S. EPA, 1992b), and EPA's public health risk assessment (U.S. EPA, 1991) has been updated. The RI/FS for the Old/No. 8 Mine Seep Operable Unit was completed in December 1992.

The first ROD for the IMM site was signed in October 1986 and addressed limited source control and water management actions in an interim remedy. The Boulder Creek OU ROD, signed in September 1992, addresses remedial actions for (1) AMD from the Richmond and Lawson portals, the two largest sources of acidity and metals contamination at Iron Mountain; and (2) the numerous waste rock piles, tailing piles, seeps, and contaminated sediments that also affect contaminant levels in Boulder Creek. The Old/No. 8 Mine Seep OU addresses the third largest source at IMM.

EPA has coordinated its site investigation and evaluation activities with those of Zeneca, Inc., (Zeneca) in a cooperative RI/FS process. (Zeneca was formerly named ICI Americas, Inc.) Zeneca represents Rhone-Poulenc Basic Chemicals Co. (formerly named Stauffer Chemical Co.). Zeneca has performed investigation activities at the site, predominantly related to the Boulder Creek OUFS.

II.5 History of CERCLA Enforcement Activities and Remedial Action

EPA's Superfund program became involved with the Iron Mountain pollution problem shortly after the enactment of the Superfund law in December 1980. On April 5, 1982, EPA issued general notices of liability to Stauffer Chemical Co. and IMMI for the past and continuing releases of hazardous substances from Iron Mountain and the resulting damage to and destruction of natural resources.

The Iron Mountain Mine site was listed on the National Priorities List in 1983. From 1983 through 1985, EPA conducted an RI/FS of the site and published its report in 1985. After public comment and publication of a Feasibility Study Addendum, EPA signed the first Iron Mountain Mine Record of Decision in October 1986. That ROD selected a partial remedy at the site, identifying a number of specific projects. These projects included the construction of a partial cap over the Richmond mineralized zone, including a cap of Brick Flat Pit; construction of a diversion in Slickrock Creek to avoid an AMD-generating slide; construction of a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling Spring Creek Reservoir; construction of a diversion of the South Fork of Spring Creek for a similar purpose; a study of the feasibility of filling mine passages with Low-Density Cellular Concrete; and an enlargement of Spring Creek Debris Dam, the exact size of which would be determined after implementation of other remedies.

During 1987 and 1988, EPA sued the property owner to gain access to the site for the purpose of constructing the first of these actions. The court granted EPA access and ordered the property owner not to interfere with the remedial actions.

On July 19, 1988, EPA initiated construction of the partial cap over the Richmond mineralized zone. As part of that construction, EPA used tailings materials from the Minnesota Flat area, as well as selected other tailings piles that contained relatively high concentrations of copper, cadmium, and zinc. EPA completed construction of the partial cap in July 1989.

EPA, through the USBR, began construction of the Slickrock Creek diversion in July 1989 and completed construction in January 1990.

Under an EPA Order, ICIA (now known as Zeneca), on behalf of Stauffer Chemical Company/Rhone-Poulenc Basic Chemicals Co., began construction of the upper Spring Creek diversion in July 1990. Construction was substantially completed in December 1990.

In addition to the activities implemented pursuant to the ROD, EPA recognized the need for additional actions in light of the drought conditions prevailing in California during the late 1980s. In the winter of 1988 through 1989, EPA operated an emergency treatment plant at the site to reduce the toxicity of the AMD releases.

The following fall, the winter-run chinook salmon was listed as a threatened species under the Endangered Species Act. In August 1989, in part due to the continuing drought conditions, EPA issued an order requiring that potentially responsible parties (PRPs) operate an emergency treatment plant at the site to reduce the toxicity of the AMD discharges for the upcoming 1989 through 1990 winter wet season and to provide for metals removal for future years until such time as remedial actions could be selected and implemented. This plant was to be comparable in scope and operation to the plant operated by EPA the previous winter. Pursuant to that order, Zeneca, on behalf of Rhone-Poulenc Basic Chemicals, constructed the treatment plant and has operated this treatment plant during the 1989 to 1990, 1990 to 1991, and 1991 to 1992 wet seasons. Because of the continuing drought in California and the critical fishery conditions, EPA issued an order on September 2, 1992, for the 1992 to 1993 wet season requiring that additional emergency measures be implemented, including increasing capacity of the treatment plant.

EPA has also issued an order requiring the PRPs to operate and maintain all EPA-constructed remedial actions as well as the actions taken by the PRPs under other orders.

EPA has identified the following persons as potentially responsible parties, parties who may be liable pursuant to CERCLA, for the cleanup of the site: the former owner and operator, Rhone-Poulenc Basic Chemicals (the successor to Mountain Copper, Ltd. and Stauffer Chemical Company), and the current owner and operator, Iron Mountain Mines, Inc., and its president and primary owner, T. W. Arman.

EPA and the State of California have brought a civil suit under CERCLA §107 against the potentially responsible parties to obtain reimbursement for government funds spent in responding to the threat at IMM. The district court has held that the cost recovery authorities of CERCLA do not allow actions against parties for response to mining wastes and has dismissed the governments' action against Rhone-Poulenc Basic Chemicals. EPA plans to appeal that ruling.

Subsequent to the ruling under CERCLA, EPA issued an amended order to the responsible parties under the authority of RCRA §7003, and the State of California issued an order under the Health and Safety Code requiring the responsible parties to continue with implementation of response actions, including construction of the treatment plant selected in the September 1992 ROD. Rhone-Poulenc has agreed to construct the simple mix peak plant and other portions of the selected remedy, and has agreed to operate the emergency treatment plant under the same conditions as last winter until the larger plant is on-line. The State of California has also filed an action in Superior Court against the responsible parties.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

EPA issued its first Record of Decision for the Iron Mountain Mine site in October 1986. EPA has issued factsheets regarding that decision and commencement of remedial design (July 1987), commencement of remedial action (July 1988), implementation of emergency response treatment actions (February 1989), and the performance of a demonstration program under EPA's Superfund Innovative Technology Evaluation (SITE) program (August 1991). EPA also updated its Community Relations Plan, which was finalized in May 1990.

EPA has regularly provided information to the local television news and the press regarding the ongoing study and cleanup actions, and this has resulted in significant local media coverage. Although the community has maintained interest in the progress of cleanup at the site, community involvement had been moderate until the winter wet seasons of 1991 to 1992. Due to the drought conditions facing California and the occurrence of a March 1992 storm which required the special release of 95,000 acre-feet of valuable water resources from Shasta Lake, community interest and involvement in the IMM site, including Old/No. 8 Mine Seep Operable Unit Feasibility Study and Proposed Plan, was significant. Federal, state, and county officials expressed interest and concern regarding cleanup progress and remedy selection.

EPA issued the Boulder Creek RI, FS, Environmental Endangerment Assessment, an updated public health Risk Assessment, Administrative Record, and the Boulder Creek Operable Unit Proposed Plan for public review on May 20, 1992. To fulfill the requirements of CERCLA Section 113(k)(2)(B)(i-v) and Section 117, EPA made these documents available to the public both at the EPA Records Center in San Francisco, California, and at the official information repository at the Shasta County Library in Redding, California. EPA also made the above documents and the large majority of the Administrative Record available to the public at the Meriam Library of the California State University at Chico, California. A public comment period was held. In addition, a public meeting attended by 200 people was held in Redding, California, at the Red Lion Hotel on June 11, 1992. At this meeting, representatives from EPA, the California Regional Water Quality Control Board, Department of Toxic Substances Control, and Department of Fish and Game made presentations regarding the remedial alternatives under consideration. EPA answered questions regarding the remedial alternatives under consideration and problems at the site. EPA received 19 formal oral comments at the meeting.

EPA received approximately 100 comment letters from the public during the public comment period. EPA responded to these comments in a Responsiveness Summary, which is part of the Record of Decision for the Boulder Creek OU, the second ROD for the IMM site.

EPA issued the Old/No. 8 Mine Seep RI/FS, the Administrative Record, and the Old/No. 8 Mine Seep Operable Unit Proposed Plan for public review on February 11, 1993. To fulfill the requirements of CERCLA Sections 113(k)(2)(B)(i-v) and 117, EPA made these documents available to the public both at the EPA Records Center in San Francisco, California, and at the official information repository at the Shasta County Library in Redding, California. EPA also made the above documents and the Administrative Record available to the public at the Meriam Library of the California State University at Chico, California. The notice of availability of these documents was published in the Redding *Record Searchlight* on February 11, 1993. A public comment period was held from February 11, 1993 through April 15, 1993. In addition, a public meeting attended by 100 people was held in Redding, California, at the Red Lion Hotel on February 25, 1993. At this meeting, representatives from EPA made presentations regarding the remedial alternatives under consideration. EPA answered questions regarding the remedial alternatives under consideration and problems at the site. EPA received three formal oral comments at the meeting.

EPA received comment letters from the public during the public comment period. EPA responded to these comments in a Responsiveness Summary, which is part of the Record of Decision for Old/No. 8 Mine Seep OU.

EPA has received an application for a Technical Assistance Grant (TAG) from the Shasta Natural Science Association, which is associated with the Carter House Natural

Science Museum in Redding, California. The purpose of the TAG is to help interpret for the layperson the scientific and engineering information developed as a part of the Iron Mountain Mine Superfund cleanup action. The original application was received in January 1992. The application was revised and resubmitted on July 22, 1993. EPA expects to issue a decision on this grant in September 1993. If approved, the TAG will provide $48,875, with the Shasta Natural Science Association contributing up to $29,900 in matching funds.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT WITHIN SITE STRATEGY

IV.1 Role of the Remedial Action

In accordance with the program management principles identified in the NCP and 40 C.F.R. §300.430(a)(1)(ii)(A) and (B), EPA has designated the Old/No. 8 Mine Seep as an operable unit.

EPA has determined, in conference with the California support agencies, that this designation of the Old/No. 8 Mine Seep Operable Unit will allow the EPA to focus its RI/FS efforts on this large and complex Superfund site to more quickly achieve a significant risk reduction and ultimately expedite the total site cleanup. To achieve the greatest risk reduction in an expeditious manner, however, it has been necessary to focus the FS further to take into account the following observations:

- The Old/No. 8 Mine Seep AMD discharges have been identified by EPA's RI efforts as the third largest source of metal contamination on Iron Mountain. The seep discharges an estimated 30 percent of the copper and 3 percent of the cadmium and zinc discharged from IMM. Remediation of this source would provide an immediate significant reduction in acid water and heavy metals loading to the environment.
- The Old/No. 8 Mine Seep is drainage from at least one and probably both of these mines. The portals of the two mines were covered by a landslide in 1955 and are inaccessible. A part of the drainage may come from landslide deposits adjacent to or above the mine portals.
- Results from implementation of remedial actions for sources in the Old/No. 8 Mine Seep Operable Unit will be important considerations in setting remedial action objectives for an overall final site remedy. If, as expected, water management capabilities remain a component of the final site cleanup plan, the degree of success in halting or reducing the AMD discharge will affect the ultimate design and cost of the water management system.

IV.2 Scope of the Problem Addressed by the Remedial Action Selected

The Old/No. 8 Mine Seep OUFS considers remedial alternatives for the largest sources of acidity and metals contamination in the Slickrock Creek drainage. Because this FS represents only an interim remedy for a portion of the site, consideration of alternatives for this source takes into account the need to be consistent with future remedial action and the need to reduce significant risks as soon as possible.

EPA expects to require an additional study of the sources in the Slickrock Creek drainage; sediments in Slickrock Creek, Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River; and other impacted areas and sources of contamination. The additional study will also assess potential water management options, including the need to coordinate releases of acidic waters with Central Valley Project water releases. EPA is currently developing a work plan for this additional RI/FS activity.

V. SITE CHARACTERISTICS

V.1 Contamination

The AMD discharges from the Old/No. 8 Mine Seep at the base of the large debris slide at IMM. This AMD is attributed to sources within the Old Mine and No. 8 Mine on the Slickrock Creek side of Iron Mountain because of its character and pattern of discharge. These workings are, however, inaccessible due to the thick cover of debris which has slid over these workings. The debris is sidecast materials from the operation of the Brick Flat Pit open pit mine. AMD flows year-round from the Old/No. 8 Mine Seep. This flow has been monitored for flow rate and water quality on a regular basis since 1978, as shown in Table 1. Flow from Old/No. 8 Mine Seep does not show sharp peaks, although the flow rate will increase following a large winter storm. The estimated average annual flow for Old/No. 8 Mine Seep is 59 gpm. The pH is commonly between 2 and 3.

Table 1
Summary of Water Quality and Flow Data for Old/No. 8 Mine Seep, 1978 to 1990

	No. of Samples	Mean[a]	Minimum	Maximum
Flow (gpm)	278	59	15	231
pH	218	2.58	1.15	3.5
Copper, total (mg/l)	286	133	59	250
Zinc, total (mg/l)	283	55	19.3	140
Cadmium, total (mg/l)	282	0.49	0.20	1.17

[a]Mean average calculated as sum of samples divided by number of samples.

V.2 Location of Contamination and Known or Potential Migration Routes

As discussed above, analytical data collected over 40 years indicate that Iron Mountain is releasing large quantities of contaminants to the environment (primarily surface water) via AMD discharges. The AMD is characterized by low pH (1 to 3) and very high concentrations of heavy metals.

The water quality parameters of concern from a public health exposure perspective are pH, cadmium, copper, and zinc. These parameters are selected because of potential dermal contact effects caused by low pH and potential consumption of AMD (with these three metals being of greatest concern from a water consumption perspective).

The contaminants of concern from the perspective of fisheries (salmon and steelhead trout) exposure are pH, cadmium, zinc, copper, and aluminum. These parameters are selected because of their toxicity, primarily to salmonids, at low pH levels and concentrations ranging from 1 μg/l for cadmium to 100 μg/l for aluminum (copper toxicity levels are in the range of 10 μg/l, and zinc toxicity levels are in the range of 50 μg/l). For comparison, 1 μg/l equals 0.001 mg/l.

The contaminants of concern with respect to terrestrial wildlife include arsenic as well as those listed above for aquatic species.

The major mechanism for onsite and offsite transport of contaminants is surface water. The AMD enters Boulder and Slickrock Creeks, and these two creeks discharge into Spring Creek, which flows to the Sacramento River at Keswick Reservoir.

The major processes that appear to affect the fate of transported copper, cadmium, and zinc are coprecipitation with iron hydroxides or precipitation as carbonates. Metals concentrations are further reduced and surface-water pH is raised by dilution as Spring Creek discharges into the main body of Keswick Reservoir (Figure 1).
AMD from the Old/No. 8 Mine Seep is physically transported by a short open-topped flume to a copper cementation plant located near the seep in Slickrock Creek valley. The flume has, at times, overflowed and leaked at joints, which acidifies the receiving soil and deposits highly concentrated metal salts into the terrestrial wildlife habitats. The degree of consumption of these salts by deer and other animals is not presently known.

The contaminants of concern can be biologically transported through the aquatic food chain. For example, the initial uptake of contaminants would be by phytoplankton, periphyton, and other aquatic vegetation. These food sources would be ingested by benthic invertebrates and/or zooplankton. The plankton and benthos would be ingested by fish at subsequently higher trophic levels and ultimately consumed by birds, animals, and humans.

VI. SUMMARY OF SITE RISKS

VI.1 General

The Iron Mountain Mine Superfund site was placed on the National Priorities List on September 8, 1983. The site was listed because of the impacts of metals-laden AMD discharges on the Sacramento River, a major fishery and source of drinking water for the City of Redding and other domestic water supplies. The Iron Mountain site has been associated with water quality degradation and impacts on aquatic resources in nearby drainages during much of its history. Impacts include numerous fish kills in the upper Sacramento River (39 documented fish kills since 1940), the primary salmon-producing river in California (CDWR, 1985; CDFG, 1990). In addition, those portions of Boulder Creek, Slickrock Creek, and Spring Creek that receive AMD from Iron Mountain are essentially devoid of aquatic life.

The rationale for the Old/No. 8 Mine Seep Operable Unit is to address elevated metals loadings emanating from Slickrock Creek into Spring Creek and subsequently entering the Sacramento River. From the results of the RI, the Endangerment Assessment, and the ARARs analysis, two problem areas are identified for remedial action—human health risks and environmental risks.

VI.2 Human Health Risks

The potential for direct human exposure to AMD is relatively small. The property owner has posted the property to discourage trespassers who might become exposed. The property is located between two heavily used national forests, however, and direct exposure cannot be ruled out as a possibility.

Persons who might come into direct contact or consume concentrated AMD at Iron Mountain could be at risk. Such persons include people working, living, or hiking at the site. Individuals who enter the Iron Mountain site are at risk if they have direct contact with or ingest the AMD. The risk of such exposure is limited by controlled access to the minesite.

Persons who might come into direct contact with surface water downstream from Iron Mountain include people working, living, hiking, or swimming near the site. Individuals who come in direct contact with water or sediments from the main body of Keswick Reservoir or Sacramento River are not currently at risk.

Persons who might consume surface water downstream from Iron Mountain include people working, living, or hiking near the site. Persons who might consume fish taken from the Sacramento River downstream from Iron Mountain include the general population in the upper Sacramento River Valley. Risks from fish consumption are of concern to the community. Individuals who consume fish from the main body of Keswick Reservoir or Sacramento River may currently be at some risk; however the uncertainties associated with this scenario are great and likely would result in the risk being overestimated. EPA will continue to assess such impacts in its continuing studies at the site.

Children are at somewhat greater risk than adults when considering noncancer toxicity resulting from incidental ingestion of creek water downstream from Iron Mountain.

VI.3 Environmental Risks

The principal risks posed by the runoff of metals-bearing AMD from Iron Mountain are the associated impacts on aquatic life in the Spring Creek drainage, Keswick Reservoir, and the Sacramento River downstream of Keswick Dam. Among these natural resources, the most important are the fishery resources in the Sacramento River downstream of Keswick Dam. Migratory populations of chinook salmon, steelhead trout, resident trout, and numerous other aquatic and terrestrial species can be or are affected by AMD from Iron Mountain (U.S. EPA, 1992b).

The salmon and steelhead trout populations have high commercial and/or recreational value to the region (USFWS and USBR, 1984; USFWS and CDFG, 1987). The susceptibility of these populations to contaminants originating from Iron Mountain has been documented (Wilson, 1982). One of the chinook salmon runs, the winter run, is a species listed by the Federal Government as threatened with extinction and listed by the State of California as a species endangered with extinction.

Pollution from Iron Mountain is considered to be a major factor causing the decline in Sacramento River fishery resources, and an impediment to achieving fishery resource restoration goals. Other major factors contributing to the decline include loss of spawning habitat, predation, habitat degradation, mortality at dams and diversions, overfishing, and natural disasters (such as drought) (Vogel, 1989). Fish migrating into the uppermost river reach of the Sacramento River risk being killed by AMD from Iron Mountain; offspring of adult fish spawning in that reach have reduced chances of survival due to the Iron Mountain AMD (Finlayson and Wilson, 1979). There is an indication that AMD from Iron Mountain has reduced the suitability of available spawning grounds for salmon in the uppermost reaches of the Sacramento River and that fish population reductions have occurred following uncontrolled spillage of Iron Mountain AMD (Finlayson, 1979). The greatest decline in salmon-spawning populations has occurred within the uppermost river reach from Balls Ferry upstream to Redding, a distance of approximately 26 river miles (NOAA, 1989).

Since the late 1960s, when fish counts were initiated at Red Bluff Diversion Dam (RBDD), each of the anadromous salmonid runs has suffered major declines. A more extensive data base is available specifically for fall-run chinook. This data base demonstrates that recent levels of spawning escapement to the upper Sacramento River are only about 50 percent of levels observed during the late 1950s. The greatest decline among the salmon runs has occurred for the winter run, which has been reduced to less than 5 percent of run sizes during the late 1960s. This serious decline prompted the 1989 listing of this fish as a threatened species by the Federal Government (NMFS, 1989) and an endangered species by the State of California (CDFG, 1989).

The primary potential exposed fisheries populations are the salmonids and steelhead trout present in the Sacramento River; Boulder Creek, Slickrock Creek, and Spring Creek are devoid of fish and aquatic invertebrates below the mine drainage area. The upper Sacramento River chinook salmon runs, steelhead trout run, and resident populations of rainbow trout have life history characteristics that make them vulnerable to potential adverse effects from AMD originating from Iron Mountain. The probability and magnitude of potential exposure depends on the releases of contaminated water from SCDD, the releases of water from Shasta Dam, and the life stages present within the zone of impact.

For spring- and fall-run chinook salmon, in a worst-case scenario, approximately half of an entire year's fall spawning production could be at risk from contaminants released from Iron Mountain. The impact of the release depends in large part on the pattern of releases from Shasta Dam relative to when releases occur from IMM. For example, flood control releases from Shasta Dam could cause most of the year's production to migrate downstream of the affected water quality zone, thereby reducing the AMD's impact.

Winter-run chinook salmon could be at higher risk compared to other runs. They are most likely to seek cooler water areas closest to Keswick Dam because of potentially lethal water temperatures in lower reaches of the Sacramento River. Under drought-type conditions, these fish are the most important to future runs because eggs laid farther downstream are more likely to be adversely affected by lethal warm water temperatures. However, these same drought conditions are more likely to create conditions (uncontrolled AMD release and low dilution in the Sacramento River) where AMD from Iron Mountain could pose a high risk to juvenile rearing in the uppermost reach of the river.

The steelhead trout and resident rainbow trout populations that are potentially at risk are not well-defined or understood. However, both the adult and yearling life phases are potentially at risk because both are present in the river when fish kills have historically occurred.

At present, a memorandum of understanding commits the USBR to operate SCDD in a manner that (when considering releases of dilution water from Shasta Dam) will protect aquatic life in the Sacramento River downstream of Keswick Dam. The USBR must also operate Shasta Dam to provide electric power, irrigation water, and flood control. The USBR estimated that during an average year it may lose between $16 million and $168 million, depending on the level of protection required in the Sacramento River, by supplying water to dilute Spring Creek flows. There is the potential that USBR's ability to supply adequate dilution water will be further reduced due to conflicting priorities for water use, thereby increasing the potential risk to the aquatic community.

It is extremely difficult to quantify fish mortality in the Sacramento River as a result of contamination from Iron Mountain Mine. This is due to a variety of factors, including the general size of the Sacramento River downstream of Keswick Reservoir and difficulty of visually observing dying or dead fish during periods when the water is turbid. However, there have been 39 documented fish kills near Redding since 1940, and there have been observations of adult steelhead mortalities near Redding attributable to metal contamination from Iron Mountain Mine since installation of the SCDD.

Boulder and Spring Creeks, downstream from Iron Mountain Mine discharges, do not support aquatic populations, and the creeks may remain sterile following remediation at Iron Mountain. Aquatic populations, water column and benthic, in Keswick Reservoir downstream of Spring Creek are at risk because of sediment contamination, as well as water column contamination. Below Keswick Dam, contaminant concentrations occasionally exceed toxic concentrations for sensitive life stages and frequently exceed both EPA and State of California criteria to protect aquatic life, indicating that these populations are also at risk.

Any terrestrial wildlife onsite has the potential for direct exposure to AMD, such as deer drinking from contaminated creeks or licking metals-laden salts along the flume system, or consuming contaminated plants, fish, or other organisms. More than 300 species of amphibians, reptiles, birds, and mammals can be expected to occur in the Boulder Creek basin and downstream areas that may be directly exposed to AMD.

VII. DESCRIPTION OF ALTERNATIVES

VII.1 General

Pursuant to 40 CFR §300.430(e)(2)(i), in developing the remedial alternatives, the lead agency shall establish remedial action objectives. The NCP requires that the remedial action attain water quality criteria established under the Clean Water Act Sections 303 and 304 where relevant and appropriate under the circumstances of the release. The remedial action objective at the site is to eliminate IMM site discharges that are harmful to the environment. The contaminants of concern identified in the 1986 ROD (U.S. EPA, 1986c) are acidity and toxic metals, which include copper, cadmium, and zinc. All of these are present in AMD from Old/No. 8 Mine Seep.

VII.2 Screening Evaluation

In general, there are two principal steps in the development of a feasibility study. The first step is a screening evaluation of all possible technologies that would apply, in this case technologies to control AMD. The second step is a detailed analysis and comparison of selected and assembled technologies. EPA conducted a screening evaluation similar to the Boulder Creek OU, which considered the concepts of mine plugging, air sealing, groundwater control, capping, physical-chemical treatment/resource recovery, biological treatment, passive treatment, fixation-stabilization treatment of sludge, landfill of sludge, surface-water discharge of treated water, and injection of treated water.

EPA has concluded that the site conditions in the Old/No. 8 Mine Seep OU restrict the number of alternatives to four general response actions:

- No Action
- Containment of the AMD and isolation of water and/or air from the sulfide rock
- Reduction in AMD discharge volume by reducing water infiltration into the mine workings
- Treatment of the AMD, disposal of sludge, and discharge of the treated water

EPA performed a screening analysis of the general alternatives. EPA concluded that only three alternatives have potential applicability to the Old/No. 8 Mine Seep AMD discharges. The Old/No. 8 Mine Seep FS includes detailed analysis and comparisons of:

- No Action

- Copper Cementation
- Treatment of the AMD, disposal of sludge, and discharge of the treated water

Following is a brief summary of the screening evaluation.

Because the No-Action alternative is required by the NCP, it is automatically forwarded to the detailed analysis.

The containment alternatives of mine plugging and air sealing were eliminated in the screening because the mine adits are not accessible, and it was concluded that construction activities to restore access would involve large costs and a great risk that access would not be achieved. The containment alternatives of groundwater control and capping were eliminated because the surface of the landslide deposits over the mine portals is too unstable to drill and maintain wells or to construct a permanent, impervious cap.

Treatment was considered both as a stand-alone response action and in combination with other technologies that would reduce the formation of AMD. Three technologies were considered for AMD treatment in the Old/No. 8 Mine Seep OUFS. The technologies are physical-chemical (resource recovery), biological, and passive.

The physical-chemical treatment systems considered were: ion exchange, liquid-liquid extraction, crystallization, and the membrane process. All of these treatment systems were screened out because of uncertainty of achieving cleanup goals and high capital and operating costs.

Copper cementation is currently being used to remove copper from the Old/No. 8 Mine Seep. Cementation is effective in reducing the copper concentrations but the process may not achieve the discharge standards for copper, and it does not reduce the concentrations of zinc and cadmium. Despite these limitations, copper cementation was judged to be technically and economically effective to complement other measures and for these reasons was retained for detailed analysis.

Neutralization/precipitation is a process that is commonly used by the mining industry for treatment of AMD and has been used successfully to reduce metals levels at the IMM site. Under the Boulder Creek ROD, it is anticipated that the final design will use a combination of high density sludge (HDS) treatment and a simple mix of AMD with soda/lime. EPA anticipates that the Richmond/Lawson treatment plant can be expanded to accommodate flow from the Old/No. 8 Mine Seep. EPA retained this process for the detailed analysis.

Microbial decomposition of waste materials requires natural or manmade wetlands, which are impractical in the Slickrock Creek valley. This innovative technology might play a supporting role in the final solution for the IMM site.

Passive treatment by evaporation requires large ponds, which are impractical in the Slickrock Creek valley. This technology is screened out.

The lime neutralization treatment processes generate sludge which can be conditioned to make it more resistant to leaching and then disposed of in a RCRA landfill or a municipal or mine waste disposal type landfill, depending on the sludge characteristics. In addition, the landfill could be onsite or offsite. These options were evaluated in the Boulder Creek OUFS. All of the disposal options are carried forward to the detailed analysis.

Water disposal options are discharge to Spring Creek, Slickrock Creek, to the Sacramento River, or injection of treated water into the mine or into the ground. Off-site disposal is screened out because it is more expensive than onsite disposal and yields the same resultant offsite water quality.

Injection and onsite surface disposal are retained for further consideration in the FS.

The general characteristics of each general response are summarized in Figures 2 and 3.

The technologies and options that have been screened out as infeasible are shown by boxes with cross-hatching. These options have been judged to be infeasible because of known technical limitations. It is unlikely that new information about the Iron Mountain Mine site or applications elsewhere would justify further consideration of these options.

The technologies and options that have been screened out because of inadequate precedent or inadequate information about their application to the Iron Mountain Mine site are shown by boxes with dashed lines. This screening is based largely upon a judgment that existing information does not provide a strong or complete case for successful application of this option. There is a possibility that additional information about the site or other applications may justify a future reexamination of these options and possibly their inclusion as part of adopted remedial alternatives. The Old/No. 8 Mine Seep OUFS relies in part upon the previous Boulder Creek ROD information and conclusions.

The feasibility study addressed three basic alternatives for control of the Old/No. 8 Mine Seep AMD. They are Alternative O/N8-0—No-Action, a mandated baseline alternative, Alternative O/N8-1—Treatment of Flow from Old/No. 8 Mine Seep, and Alternative O/N8-2—Copper Cementation of Flow from Old No. 8 Mine Seep. The main elements of these alternatives are described below.

VII.3 Alternative O/N8-0—No-Action

The "No-Action" alternative, O/N8-0, is developed and evaluated as required by the NCP in 40 C.F.R. §300.430(e)(6).

The no-action alternative is commonly used as a baseline alternative against which other alternatives are judged. As the name implies, this alternative does not include

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	None	No Action	Retained per the NCP
Containment	Mine Sealing	Low-Density Cellular Concrete	Cement grout is placed in the mine workings to seal the pyrite from groundwater	Questionable overall effectiveness, difficulty in implementing, and high cost Not retained
	Plugging	Classical Plugging	Cement plugs are placed in strategic locations to flood the mine workings, halting the generation of AMD. No efforts are made to manage the mine pool	Due to uncertainty associated with containment and mine pool quality, this option is perceived to have an unacceptably high risk The option is the least favored plugging option and is screened out Not retained
		Plugging with Mine Pool Management	Same as classical plugging except efforts are made to manage the mine pool quality and overflow	If effective, potential risk is reduced when compared with classical plugging, by mine pool conditioning, contingent containment upgrade by grouting, and monitoring Retained
	Air Sealing	Air Doors	Air seals are placed in mine workings to limit air flow, decreasing the generation of AMD	Control mine atmospheric replenishment Limited precedence and varied success Retained Ghosted
		Inert Gas Blanket	Inert gas blanket is pumped into workings to eliminate oxygen in the mine atmosphere.	Potential innovative approach to reduce the oxidation of pyrite May be used in conjunction with air doors. Retained. Ghosted.
	Groundwater Control	Vertical Barrier	Grout is injected into the bedrock to decrease its inherent permeability.	Potentially applicable in conjunction with capping or plugging to decrease groundwater flow into or out of the mine Retained
		Wells	Wells are drilled from surface to intercept groundwater prior to interaction with pyrite	High capital and operating costs and uncertain effectiveness. Not retained
		Tunnels	Gravity drainage into drifts using boreholes drilled upwards into bedrock to intercept groundwater	High capital and moderate operating costs and uncertain effectiveness Retained Ghosted
	Capping	Clay	Clay is used to limit surface infiltration above mine workings	Clay sources uncertain and performance uncertain Not retained
		Shotcrete	Pneumatically placed concrete is used to limit surface infiltration above mine workings	Effective at reducing infiltration and therefore reducing the amount of AMD that is generated inside the mine workings Resistant to erosion Retained
		Synthetic Membranes	Flexible membrane liner is constructed above mine workings infiltration Placed on prepared soil base, anchored and protected from surface damage	Similar to shotcrete May be less implementable in rugged terrain Retained
Treatment of AMD	Physical-Chemical/ Resource Recovery	Neutralization	These are the primary treatment technologies for AMD Caustic soda or a high density sludge process using lime and sulfide polishing are two viable methods	Both methods are implementable and effective in removing metals High-density sludge may be able to produce a nonhazardous sludge Retained
		Precipitation		
		Cementation	Copper bearing AMD is passed over scrap iron, plating out copper	Proven and reliable, Currently used at IMM Copper is efficiently removed Retained
		Membrane Processes	These are associated with innovative resource recovery process or secondary treatment processes	The implementability and effectiveness of the resource recovery options are less well defined than the retained processes EPA retains these options because they potentially offer lower costs than traditional treatment, and they meet the intent of the NCP to use innovative technologies Future bench scale testing may provide insight to the applicability of resource recovery Retained Ghosted
		Crystallization		
		Liquid-Liquid Extraction		
		Ion Exchange		
	Biological	Wetlands	Constructed wetlands are used to remove metals from water. This is viable only as a secondary treatment step	Current strength AMD from portals is too acidic and high in metals for wetlands Large land requirements are difficult to accommodate at the site May become viable if current quality of AMD is improved by implementing other technologies Retained Ghosted
	Passive	Evaporation Ponds	Ponds are used to evaporate AMD	Limited space and high rainfall at mine site make this difficult to implement Not retained
Disposal of Sludge	Fixation/Stabilization	Pozzolanic Agents	Materials are added to "hazardous" sludge so that it can be disposed of according to regulatory requirements	The need for fixation/stabilization is not known technology is implementable and effective Retained.
		Encapsulation		
	Landfill	RCRA landfill	Hazardous sludge can be disposed of offsite (380 miles away) or onsite	A large volume of sludge could be generated, all options are retained, except the use of the mine workings which cannot practicably be rehabilitated to comply with RCRA
		Non-RCRA Landfill	Nonhazardous sludge can be disposed of offsite (10 miles away) or onsite	A large volume of sludge could be generated, all options are retained
Discharge of Treated Water	Dilution By Surface Water	Outfall	Treated water can be discharged onsite (Boulder Creek) or offsite (Sacramento River)	The onsite option is retained because it offers equivalent effectiveness and is easier to implement Retained
	Injection	Wells	Treated water can be injected back into the flooded mine workings (also could be preadjusted to aid in buffering of the mine pool)	Potentially viable if plugging is selected for portal flow source control Retained

NOTES

1 TECHNOLOGIES AND PROCESS OPTIONS SCREENED OUT (NOT RETAINED) ARE SHOWN WITH HATCHING

2 DASHED BOXES REPRESENT OPTIONS THAT ARE NOT USED IN THIS OUFS BUT ARE NOT SCREENED OUT THESE MAY BE USED AT THE SITE IN FUTURE REMEDIAL ACTIVITIES

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FIGURE 2
SCREENING OF REMEDIAL TECHNOLOGIES FOR MINE PORTALS
IRON MOUNTAIN MINE OLD/NO. 8 MINE SEEP ROD

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	None	No action	Retained per the NCP.
Containment	Capping	Shotcrete	Pneumatically applied concrete is used to limit surface infiltration on waste piles.	Effective at preventing or reducing erosion of the waste pile. Reduces potential for generation or AMD by reducing infiltration. Implementability depends on location of waste pile. Not retained.
		Clay	Clay is used to limit surface infiltration on waste piles.	Similar to shotcrete, but less resistant to erosion, and subject to desiccation cracking. Not retained.
		Geosynthetic Membrane *	Geosynthetic cap is constructed on waste piles.	Similar to shotcrete, but may require less maintenance. Retained
	Surface Controls	Grading	Mechanical equipment is used to reshape piles to limit surface-water run-on.	Not effective unless combined with diversion system. Not retained.
		Diversion Systems	Ditches or berms are used to limit surface-water run-on to the piles.	Should be effective at controlling erosion; is most effective in combination with capping. Retained.
Removal	Excavation	Backhoes and Bulldozers	Mechanical equipment is used to remove the piles.	Commonly used; effective and implementable. Retained.
Treatment	Stabilization	Pozzolonic Agents	Materials are added to meet regulatory requirements for disposal.	The need for stabilization is not yet known; the technology is implementable and effective. Retained.
	Resource Recovery/ Physical-Chemical	Flotation Soil Washing Neutralization	Resource recovery treatment processes may be able to recover metals, plus generate a nonhazardous waste products. Some of these techniques were used previously to process ore at IMM.	The implementability and effectiveness of resource recovery is unknown, although removal efficiencies probably will be low. Not retained.
Disposal	Landfill	RCRA Landfill	Hazardous materials can be disposed of offsite (380 miles away) or at a new facility onsite.	All options are retained, except the use of the mine workings, which cannot practicably be rehabilitated to comply with RCRA.
		Non-RCRA Landfill	Nonhazardous materials can be disposed of offsite (10 miles away) or at a new facility onsite.	All options are retained.

NOTES

1. TECHNOLOGIES AND PROCESS OPTIONS SCREENED OUT ARE SHOWN WITH HATCHING.

2 * SELECTED REPRESENTATIVE PROCESS OPTIONS FOR ALTERNATIVE DEVELOPMENT.

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FIGURE 3
SCREENING OF REMEDIAL TECHNOLOGIES FOR WASTE PILES
IRON MOUNTAIN MINE OLD/NO. 8 MINE SEEP ROD

any additional remediation activities. The no-action alternative would include provisions for limited monitoring, operation, and maintenance of the copper cementation plants and operation and maintenance of the projects constructed pursuant to EPA's 1986 ROD.

Without further remediation, the AMD production and discharge at Iron Mountain is expected to continue for centuries, until such time as the sulfide-rich mineralization is completely depleted. This geochemical process is expected to continue with the same or similar pattern and intensity of the current discharges for the foreseeable future.

VII.4 Alternative O/N8-1—Treatment of Flow from Old/No. 8 Mine Seep

The 1992 ROD for the Boulder Creek OU selected treatment of the Richmond and Lawson portal flows using lime neutralization. The lime/sulfide high density sludge treatment process is specified for non-peak flows. (It is anticipated that the final design will provide that the system is switched to the simple mix treatment process for peak AMD flows.) All sludge disposal is in Brick Flat Pit. Detailed design of treatment processes for AMD are underway. As part of this design, EPA has performed a treatability study that indicates that the addition of sulfide during treatment may be counterproductive. EPA may modify its treatment approach to delete the requirements for the sulfide addition.

This alternative would entail collecting the Old/No. 8 Mine Seep AMD and pumping it to the treatment area at Minnesota Flats. The treatment facility under design includes equalization tanks, an optional copper cementation plant, and an HDS/simple mix treatment plant. Figure 4 is a conceptual schematic, and Figure 5 shows a block schematic of this treatment system.

The capacity of the proposed treatment plant for the Boulder Creek OU would have to be enlarged to treat the additional base flows with HDS and to provide for treatment of peak flow from Old/No. 8 Mine Seep of 250 gpm. The following additional improvements would also be required:

- Access road to the Old/No. 8 Mine Seep
- Additional AMD and process water conveyance
- Additional 300,000 gallons of equalization tank capacity
- Additional electrical capacity for peak flows
- Additional sludge disposal capacity

The concept for collection of the AMD at Old/No. 8 Mine Seep is to provide both surface and underground interception of the flows and closed piping to bring the flows by gravity to a collection manhole and then to a measurement manhole near the present Slickrock Creek copper cementation plant. The AMD would then be pumped 24,000 feet in a 6-inch pipeline to discharge into an elevated tank at the Minnesota Flats treatment plant.

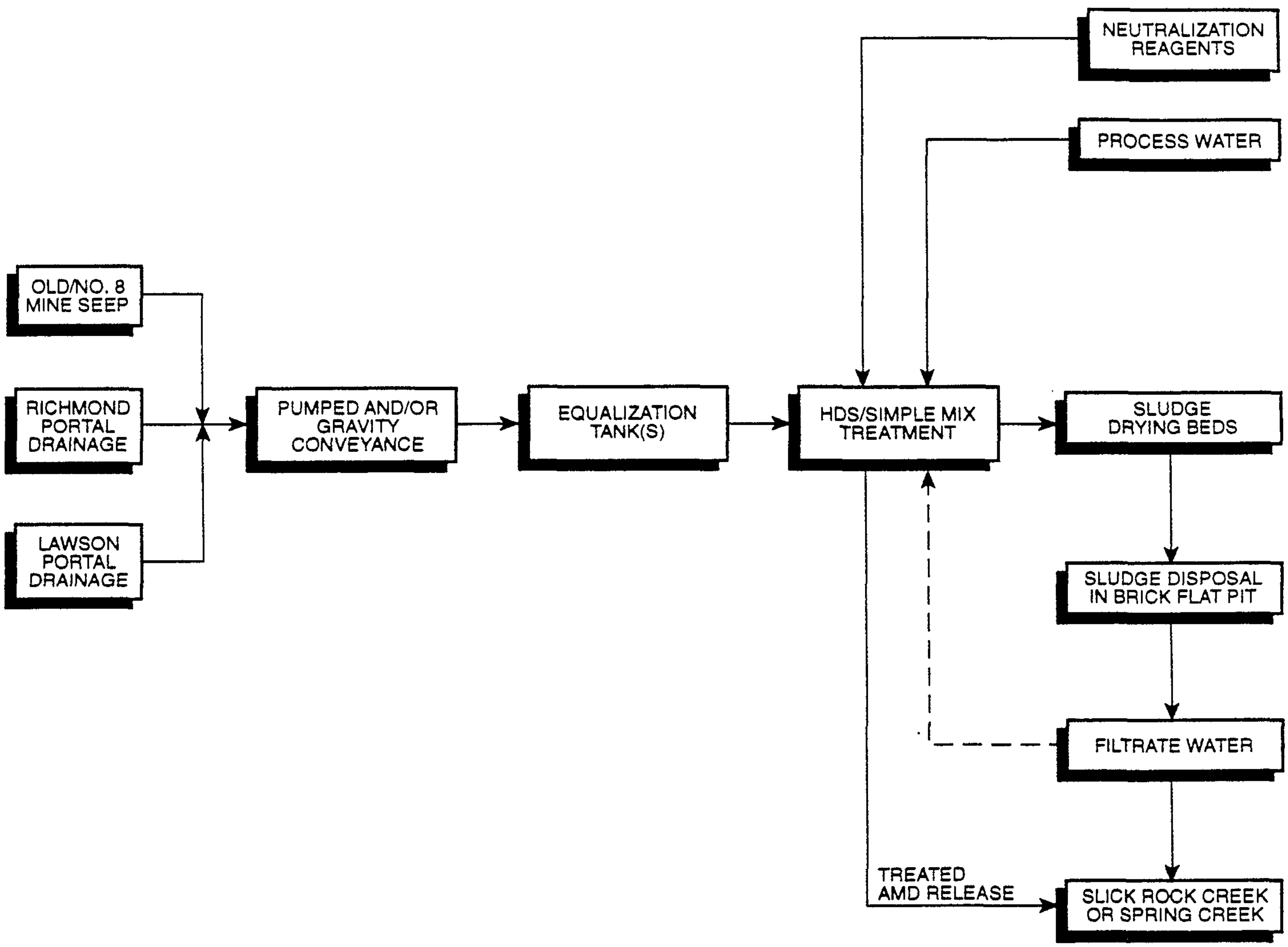

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FIGURE 4
HDS/SIMPLE MIX LIME NEUTRALIZATION
IRON MOUNTAIN MINE OLD/NO. 8 SEEP ROD

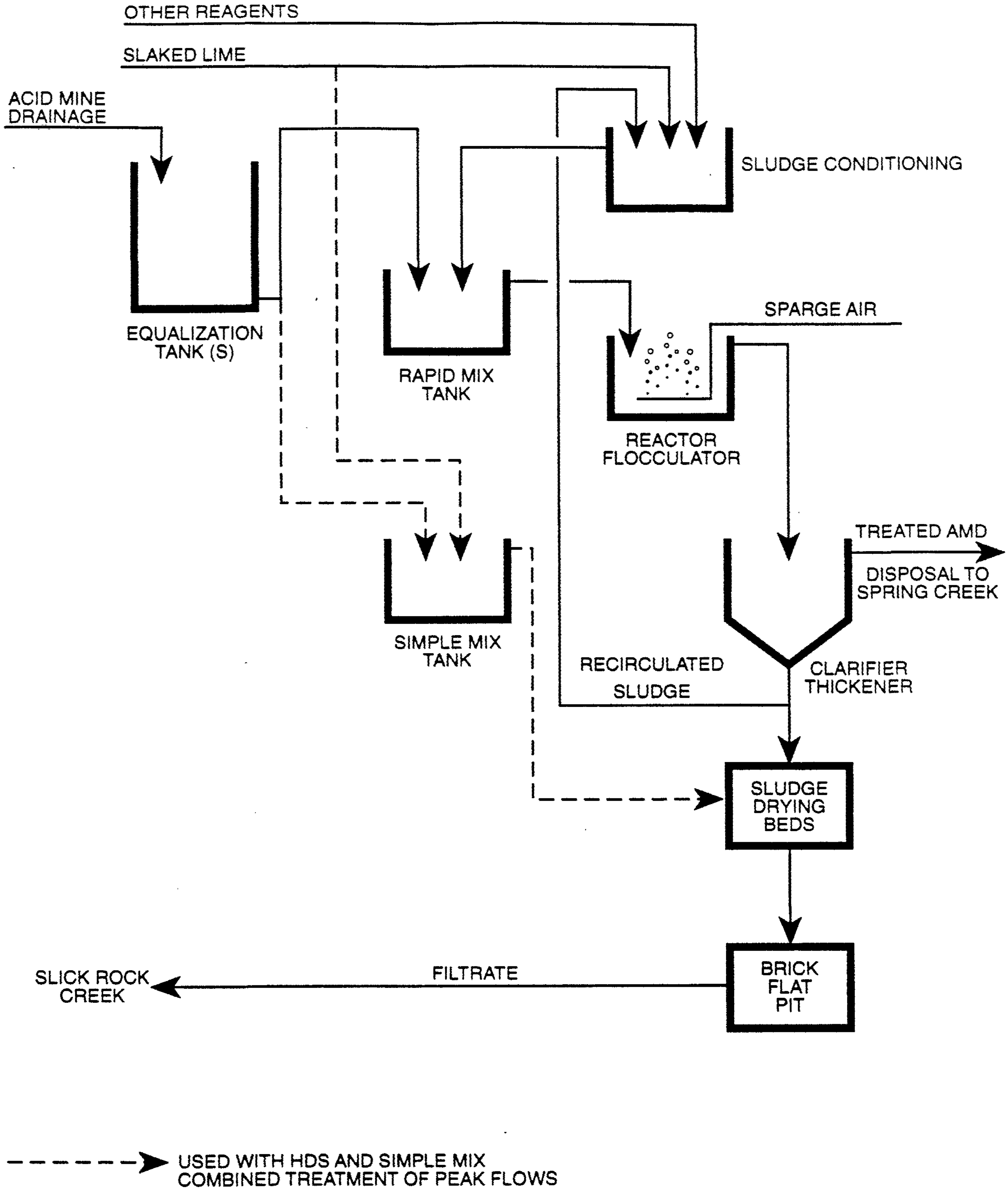

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FIGURE 5
GENERALIZED FLOW SCHEMATIC
HDS/SIMPLE MIX TREATMENT
OF ACID MINE DRAINAGE
IRON MOUNTAIN MINE OLD/NO. 8 MINE SEEP ROD

The AMD flows from the three mines will be mixed in an equalization tank to make the flows more uniform for treatment. The equalization capacity proposed for the flow from Old/No. 8 Mine Seep would require approximately 300,000 gallons.

The treatment process is described in Appendix B of the 1992 Boulder Creek OU FS. The HDS process will be used to treat normal flows, but a conversion to simple mix treatment could be used to treat the peak storm flows to avoid equipping the plant with large equalization and HDS treatment facilities to handle short-term conditions. For the Boulder Creek OU, the HDS and simple mix treatment systems were sized at approximately 300 and 1,100 gpm, respectively. To incorporate treatment of Old/No. 8 Mine Seep AMD, the HDS and simple mix treatment system capacities will be increased to 420 and 1,250 gpm, respectively.

Sludge from the treatment will be disposed in Brick Flat Pit. Sludge will be dewatered at Minnesota Flats and hauled by truck to Brick Flat Pit for disposal.

This option does not rely upon copper cementation (Alternative O/N8-2), but could be designed to allow the continued operation of a copper cementation plant to remove copper upstream of the lime treatment facility. Although copper cementation is currently required for the AMD from Old Mine/No. 8, this form of treatment/metals recovery would no longer be necessary after construction of the treatment plant. After construction of the lime treatment plant it is anticipated that the owner/operator will operate the copper cementation plant only when the price of copper justifies such operation. This alternative would not preclude such operation.

VII.5 Alternative O/N8-2—Copper Cementation

This alternative entails the collection of the Old/No. 8 Mine Seep AMD, treatment by copper cementation, and effluent discharge to Slickrock Creek. This alternative would replace the existing copper cementation plant to increase the efficiency of copper removal. An observed peak flow of 250 gpm and an average flow of 60 gpm were used to size the new plant and estimate capital and operating costs. The AMD collection system is the same as for Alternative O/N8-1. The new copper cementation plant will be on the site of the present plant. Figure 6 shows the layout of these facilities.

The copper cementation treatment system relies on the electrochemical precipitation of metal (copper in this case) by a more electropositive metal (such as iron). Copper cementation involves passing copper-bearing AMD over scrap iron, where the copper deposits and iron go into solution as ferrous iron. When the scrap iron is replaced by copper, the copper is removed and sold for its scrap value. Two copper cementation plants currently operate at the site. The process is passive, requiring only periodic manual or mechanized removal of the iron-depleted, copper-enriched scrap iron and replacement with fresh scrap iron.

Cementation is carried out in acid-resistant chambers. The AMD flows through these chambers by gravity.

As shown by the operational history or the existing onsite plant and experience with more modern plants on other sites, it is assumed that the average removal efficiency will be 90 percent. This is an increase of 20 percent over the performance of the existing plant. Based upon an average inflow of copper of 120 mg/l, the improved plant efficiency would prevent an annual discharge of 6,000 pounds of copper. The existing plant and the plant proposed in this alternative provide no removal of zinc or cadmium.

VIII. ALTERNATIVE COMPARISONS

The remedial alternatives developed in the Old/No. 8 Mine Seep OUFS were analyzed in detail using the nine evaluation criteria specified by the NCP in 40 C.F.R. §300.430(e)(9). The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative providing the best balance among the nine criteria. These criteria are: (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements (ARARs); (3) reduction of toxicity, mobility, or volume through treatment; (4) long-term effectiveness and permanence; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance. Each of these criteria is described below.

VIII.1 Criterion 1—Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

The Old/No. 8 Mine Seep OU provides for an interim action that is not expected to be final, and will not address all of the sources of contaminant discharges from the site. Consequently, even though the remedial action will provide significant environmental benefit, it is not expected to be fully protective of human health and the environment. The remedial actions will address the third largest source of AMD at the site, the Old/No. 8 Mine Seep, and will provide a significant contribution toward the final site cleanup. The remedial actions considered are intended to provide protection of human health and the environment from the exposure pathway or threat posed by AMD from Old/No. 8 Mine Seep. The comparative analysis of the alternatives is made on this basis and on the basis of their contribution toward meeting the final cleanup goal.

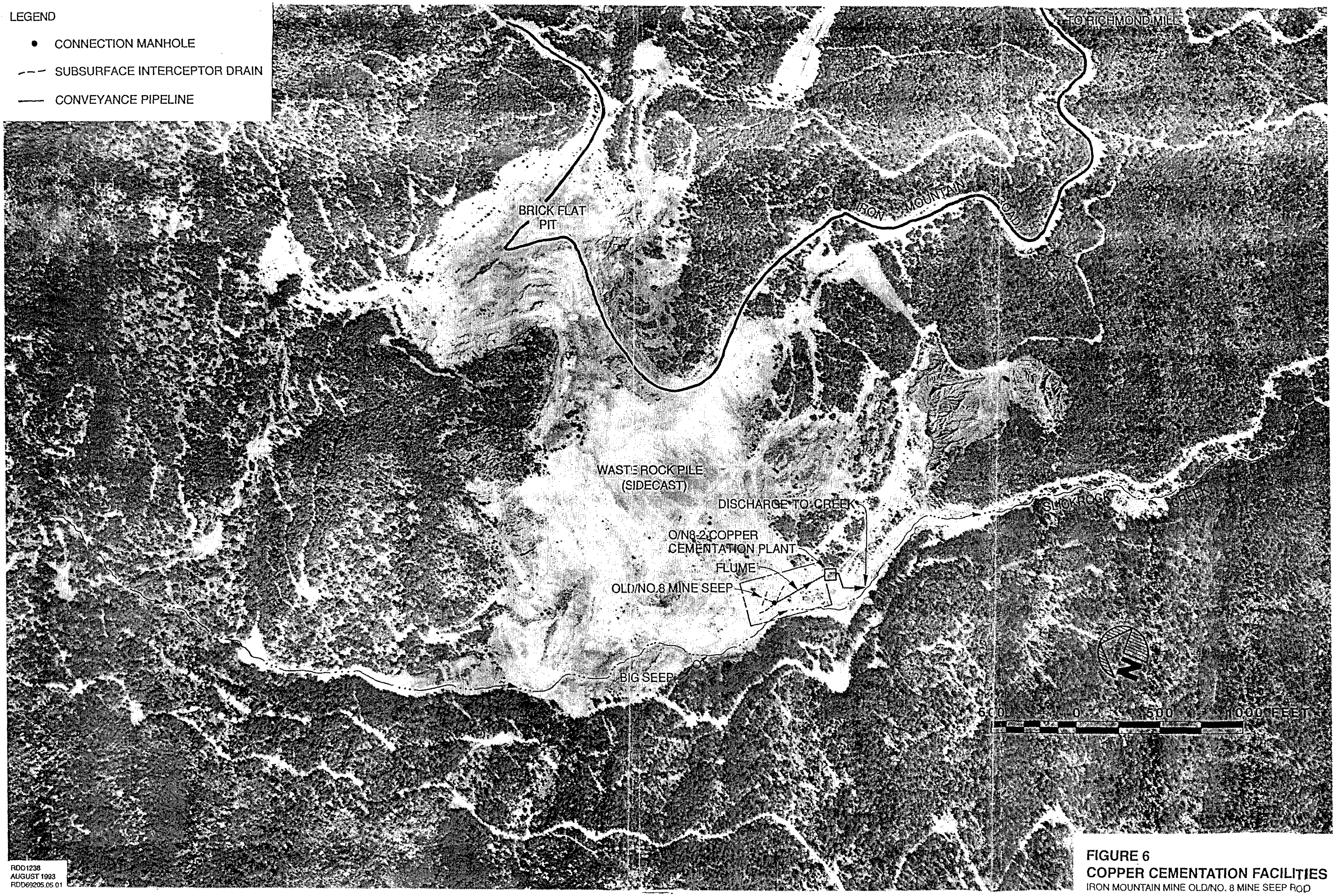

FIGURE 6
COPPER CEMENTATION FACILITIES
IRON MOUNTAIN MINE OLD/NO. 8 MINE SEEP ROD

Treatment of the AMD should contribute to protection of human health, although this is not considered a major issue for either the no-action or the action alternatives. It is not considered a major issue because the concentrated acidic waters are mainly limited to remote and uninhabited areas, these source areas have restricted entry, and human exposure to the dilute waters is limited.

The level of environmental protection among the alternatives considered ranges from limited to good. The no-action alternative provides only a continuation of the controls now in place, namely the existing flume for AMD conveyance, the cementation plant, and the Slickrock Creek Diversion. Effluent from the cementation plants will continue with undiminished zinc and cadmium, significantly reduced amounts of copper, and a low pH. Present impacts are likely to continue. Old/No. 8 Mine Seep degradation of Slickrock Creek and downstream impacts would continue.

Alternative O/N8-1 would neutralize the acidity of the Old/No. 8 Mine Seep AMD and remove more than 99 percent of the metals from the seep flow.

From a comparison of case years 1978, 1980, 1981, and 1983, the water at the Slickrock Creek confluence with Spring Creek, while considerably improved, would still not meet the water quality criteria for copper, cadmium, or zinc at all times. These years have a span of annual rainfall representative of all of the years of record. Below the confluence of the two creeks and below Keswick Dam, Alternative O/N8-1 would provide enough copper removal to allow the retention and controlled release of SCDD to achieve compliance with water-quality criteria for all of the case years 1980 and 1983, and greater compliance with the criteria than would occur under the no-action alternative in other years.

Construction of pipelines shall be conducted primarily along roads, resulting in minimal impact on vegetation. On the basis of this comparison, Alternative O/N8-1 would have a very positive impact on achieving the overall remedial action objectives for the site.

Alternative O/N8-2 would result in the removal of an additional 6,000 pounds of copper per year when compared with the no-action alternative. This additional removal of copper could potentially reduce the days of non-compliance associated with copper. However, copper cementation is not expected to reduce the amount of cadmium or zinc, which individually and in combination appear to be the cause of non-compliance at the confluence of Slickrock and Spring Creek.

In summary, the no-action alternative provides environmental protection that is limited to the removal of most copper only; the treatment alternative, O/N8-1, provides for a significant improvement in protection for aquatic resources in that it removes 99 percent of all metals, and the improved copper cementation alternative, O/N8-2, would improve copper removal but not provide protection from zinc or cadmium.

VIII.2 Criterion 2—Compliance with Applicable or Relevant and Appropriate Requirements

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental siting law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

Compliance with ARARs addresses whether a remedy will meet all Federal and State environmental laws and/or provide a basis for a waiver from any of these laws. These ARARs are divided into chemical-specific, action-specific, and location-specific groups. Iron Mountain Mine ARARs are discussed in greater detail in Chapter 3 of the Old/No. 8 Mine Seep RI/FS, and in the September 30, 1992, ROD in Section X.2.

Chemical-Specific ARARS. For the purpose of comparative analysis, the Old/No. 8 Mine Seep OUFS considered compliance with three specific water quality goals at two locations for each of the alternatives. The three goals were:

- State of California water quality objectives in the Central Valley Regional Water Quality Control Board Basin Plan (CVRWQCB Basin Plan)—the most stringent water quality requirements.
- Federal Clean Water Act—ambient water quality criteria for protection of human health.
- Federal Clean Water Act—ambient water quality criteria for protection of aquatic life in freshwater.

The maximum contaminant levels specified by selected ARARs are presented in Table 2. The two points of compliance were:

- Confluence of Slickrock Creek with Spring Creek
- Sacramento River below Keswick Dam

The benefits of implementing the alternatives of Old/No. 8 Mine Seep OUFS were tested by estimating the water quality with each of the alternatives in operation under the patterns of precipitation in 1978, 1980, 1981, and 1983. The results indicate that Alternatives O/N8-1 and O/N8-2 would both reduce the days of non-compliance with respect to the no-action alternative, but neither would eliminate non-compliance. The modeling using the most stringent standard (CVRWQCB Basin Plan) for water quality

STATE OF CALIFORNIA - Environmental Protection Agency PETE WILSON, Governor

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PHONE: (916) 224-4845
FAX: (916) 224-4857

17 September 1993

Mr. David Jones
U. S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, CA 94105

DRAFT ROD - OLD/NO. 8 SEEP

We have reviewed the agency draft of the Record of Decision (ROD) for the Old/No. 8 mine seep.

We concur with the selection of neutralization treatment as an interim remedy for control of acid and metals emanating from the Old/No. 8 mine seep. As discussed in the DTSC response letter (9 September 1993), we are not at this time recommending a specific treatment process. We concur with the DTSC proposal to evaluate sludge characteristics from the aerated simple mix plant and then determine if HDS is warranted. Given the relatively high cost of treatment and the problems with sludge disposal, efforts should be made to replace treatment technology at the earliest possible date with remedial action which prevents or reduces the formation of acid mine drainage.

The Slickrock Creek basin in the vicinity of Old/No. 8 mine has been shown to be a significant source of additional Cu loading from Iron Mt. Mine. We request that there be a continued effort to identify the actual source of this additional Cu load and an evaluation of feasible control actions.

If you have any questions, please contact Dennis Heiman of my staff at (916) 224-4851, or the above address.

Dennis Heiman for

James C. Pedri, P.E.
Supervising Engineer

DRH:tch

cc: Mr. Anthony Landis, DTSC, Sacramento
Mr. Harry Rectenwald, Department of Fish and Game, Region 1, Redding

Table 2
Maximum Contaminant Levels Specified by Selected ARARs ($\mu g/l$)

ARAR	Copper	Zinc	Cadmium
California State Central Valley Water Quality Control Board Basin Plan	5.6	16	0.22
Federal Clean Water Act water quality criteria for protection of human health	1,300	none	10
Federal Clean Water Act ambient water quality criteria for protection of aquatic life in freshwater[a]	12.0	110	1.1
Safe Drinking Water Act	1,000	5,000	10

[a]Based on a water hardness of 100 mg/l. The values reported are for a 4-day average continuous concentration.

below Keswick Dam predicted 52 days of non-compliance per year for the no-action alternative (O/N8-0) and copper cementation (O/N8-2) and 47 days for treatment of flows (O/N8-1). The model using the Federal Clean Water Act Ambient Water Quality Criteria below Keswick Dam shows 12 days of noncompliance for ON8-0, 9 days for ON8-1, and 11 days for ON8-2.

The Old/No. 8 Mine Seep OU provides for an interim action that it is not expected to be final and does not address all of the sources of discharges from the site. Therefore, it is not expected to fully comply with all ARARs with respect to water quality standards for metals concentrations in surface waters and State Fish and Game standards. Although the remedial actions evaluated in the Old/No. 8 Mine Seep OUFS provide for significant improvement by essentially eliminating the third largest discharge from the site, EPA is relying upon the ARARs waiver for "Interim Measures" (40 C.F.R. § 300.430 (f)(1)(ii)(C)(i) for remedy selection with respect to the Old/No. 8 Mine Seep OU and therefore is waiving the Regional Board's Basin Plan water quality objectives and the Fish and Game §5650 standards ARARs for this operable unit. EPA's overall goal at the site remains to achieve these water quality objectives and Fish and Game standards. The alternatives for this Operable Unit otherwise will comply with ARARs, including ARARs for sludge disposal.

ARARs are discussed in greater detail in the feasibility study for the Old/No. 8 Mine Seep Operable Unit (U.S. EPA, 1993).

The treatment of flow in an expanded treatment plant will make a significant contribution to the goal of complying with water quality standards. The no-action and O/N8-2 copper cementation alternatives are less effective because they do not remove cadmium and zinc.

Location-Specific ARARs. The Old/No. 8 Mine Seep OUFS provides a detailed description of possible location-specific ARAR's. All of the alternatives are expected to meet location-specific ARARs, some of which ensure that wetlands, historical, or archaeological sites are not damaged or disturbed.

Action-Specific ARARS. Significant action-specific ARARs include those that address the need to protect species and those that relate to the safe disposal of wastes. All three alternatives are consistent with statutes such as the Federal and California Endangered Species Acts and the Fish and Wildlife Coordination Acts and Fish and Game Code Section 1505. Alternatives O/N8-1 and O/N8-2 improve habitat and will therefore provide greater compliance.

Alternative O/N8-1 is the only alternative that would require disposal of sludge. The disposal unit at Brick Flat Pit is being designed by EPA to comply with the provisions of California Water Code Section 13172 and Health and Safety Code Section 25208, et seq. (Toxic Pit Control Act). These ARARs are applicable to the disposal of the sludge.

Table 3 is a summary of the alternatives' ability to meet objectives of protecting human health and the environment and achieving ARARs.

Table 3
Summary of Overall Protection of Human Health and the Environment and Achievement of ARARs

Alternatives	Overall Protection of Human Health and the Environment and Achievement of ARARs
O/N8-0 No-Action	• Human health risk likely to be low. • Present environmental impacts are likely to continue and may increase in severity with prolonged exposure to contaminated water and increased volume of contaminated sediments. • Cementation removes about 70 percent of the copper, but does not remove other metals or reduce acidity. • Will not meet ARARs.
O/N8-1 Treatment of Flow	• Human health risk likely to be low. • Significant reduction in environmental impacts with up to 99 percent reduction in metals and acidity. • This interim action will not provide full compliance with ARARs. • The large anticipated reduction in metals in the discharges is a significant contribution to final cleanup standards
O/N8-2 Copper Cementation of Flow	• Similar to O/N8-0, with an additional removal of copper • This interim action will not provide full compliance with ARARs.

VIII.3 Criterion 3—Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

All of the alternatives considered control the contaminated flow and have no effect on the geochemical reactions that generate the AMD. The alternatives will remain effective as long as the conveyance systems and treatment plant operations are maintained. For Alternative O/N8-1, assuring adequate disposal capacity is part of the long-term remedy. The current pit disposal has a capacity for at least 60 to 100 years.

VIII.4 Criterion 4—Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the site.

Geochemical reactions are anticipated to continue for hundreds of years unless alternative technologies are developed, adequately tested, and applied to the site. The no-action alternative will continue to reduce flow toxicity associated with copper, and the copper cementation will improve on this reduction by removing additional copper. Alternative O/N8-1 will reduce flow toxicity associated with copper, zinc, cadmium, and low pH. Alternatives O/N8-0 and O/N8-2 do not reduce the mobility, toxicity, or volume of zinc and cadmium, but will reduce the volume of copper without requiring disposal. All metals treated at Minnesota Flat (O/N8-1) will have reduced mobility and will be appropriately disposed of in Brick Flat Pit. Brick Flat will be equipped with an underdrain system further limiting any future remobilization of metals.

In summary, the comparison is essentially between not addressing the actual AMD toxicity and mobility for zinc, cadmium, and pH in Alternative O/N8-0 and O/N8-2 and the potential mobility of 99 percent of all metals treated and disposed of as a sludge in compliance with disposal standards. O/N8-1 will provide a greater overall reduction in AMD toxicity, mobility, and volume through treatment.

VIII.5 Criterion 5—Short-Term Effectiveness

Short-term effectiveness refers to the period of time required to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

Alternative O/N8-1 ranks first in short-term effectiveness as it provides the greatest improvement in surface-water quality and does not involve unusual worker or environmental risks. Alternative O/N8-2 is less effective than O/N8-1, but it is better than O/N8-0. It also has no unusual worker or environmental risks.

VIII.6 Criterion 6—Implementability

Implementability refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution. It also includes coordination of Federal, State, and local governments to clean up the site.

Alternatives O/N8-1 and O/N8-2 are also fairly simple to implement in that they involve established technologies with known costs, effectiveness, and reliability. Alternative O/N8-1 is somewhat more complex than 0/N8-2 because it requires sludge disposal. All of the alternatives are easily reversible in the event other technologies become available.

VIII.7 Criterion 7—Cost

This criterion examines the estimated costs for each remedial alternative. For comparison, capital and annual O&M costs are used to calculate a 30-year present worth cost for each alternative.

Table 4 presents estimates of the 30-year present worth for the alternatives. The table shows the present worth of the initial capital investment, 30 years of operation, and the total 30-year cost. The 30-year basis is selected merely to compare the early costs of all alternatives. Unless another remedial action is subsequently developed which obviates the need for continued treatment, treatment of the seep is expected to be required beyond the 30-year costing period. The total present worth costs range from $8.3 million for O/N8-1 to $1.7 million for Alternative O/N8-2. It is commonly assumed that actual cost may vary from the stated amounts by as much as plus 50 percent to minus 30 percent.

Table 4
Summary of Costs

Alternatives		Present Worth Basis		
		Capital Costs ($)	Operating Costs ($)	Total Costs ($)
O/N8-0	No-Action	-0-	446,000	446,000
O/N8-1	Treat seep flow at a treatment plant co-located with the Boulder Creek operable unit plant	4,350,000	3,920,000	8,270,000
O/N8-2	Treat seep flow with a new copper cementation plant located near the seep	905,000	753,000	1,658,000

VIII.8 Criterion 8—State Acceptance

State acceptance refers to the State's position and key concerns related to the preferred alternative and other alternatives, and State comments on ARARs or the proposed use of waivers.

EPA has worked closely throughout the Old/No. 8 Mine Seep OU with the California Department of Toxic Substances Control (DTSC) (the State lead agency), the Regional Water Quality Control Board (RWQCB), and the Department of Fish and Game. All three agencies support the selection of EPA's preferred alternative, treatment of the Old/No. 8 Mine Seep AMD flows.

In an April 15, 1993, letter, DTSC supported the selection and implementation of treatment. The Department urged EPA to implement this remedy as soon as possible to allow for its integration with ongoing design and construction of the Boulder Creek OU treatment plant. DTSC views treatment as an interim remedy and encourages the further development and consideration of an alternative that could reduce or eliminate the need for treatment at the site, including capping, plugging, and resource recovery approaches. DTSC expressed concern that the disposal facility for the treatment residuals be properly designed. EPA has agreed that the disposal facility must meet the appropriate design criteria.

The Department of Fish and Game signed an April 14, 1993, letter along with the other Natural Resource Trustees for the site, supporting the selection of treatment of the Old/No. 8 Mine Seep AMD discharges. These agencies recommend that EPA proceed expeditiously with additional site investigations and cleanup actions.

VIII.9 Criterion 9—Community Acceptance

This criterion refers to the community's stated preferences through verbal and written comments on EPA's Proposed Plan regarding which components of the alternatives interested persons in the community support, have reservations about, or oppose.

There was significant community interest in EPA's Proposed Plan for the Old/No. 8 Mine Seep OU at IMM. EPA's public meeting was attended by approximately 100 people. EPA received three oral comments at the meeting. EPA received letters commenting on the Proposed Plan. In general, the community expressed interest in selecting a remedy that would safely protect the water and fishery resources that could be implemented quickly, and that could remediate permanently the long-standing site problems.

There was overwhelming support from the community to take immediate action at the site. The community supported treatment of the AMD discharges as a logical extension of EPA's September 1992 ROD. The community supports the use of the inactive open pit mine, Brick Flat Pit, for sludge disposal.

Zeneca, on behalf of Rhone-Poulenc Basic Chemicals, submitted detailed comments in support of its conclusion that operation of the existing copper cementation plant, the no-action alternative (O/N8-0), was the preferred approach and could be safely implemented, would be effective, and was the lowest-cost option.

Iron Mountain Mines, Inc., (IMMI) submitted detailed comments in support of its preferred approach, in situ mining of the mineralized zones. IMMI opposed EPA's reliance upon Brick Flat Pit for sludge disposal. IMMI stated its interest in mining the remaining sulfide deposit in Brick Flat Pit.

Responses to the above comments are presented in the attached Responsiveness Summary.

IX. THE SELECTED REMEDY

EPA is selecting collection and treatment of the Old/No. 8 Mine Seep AMD flows. Treatment sludges will be disposed of onsite in the inactive open pit mine, Brick Flat Pit.

The selected remedy differs in one minor respect from the preferred alternative in EPA's February 11, 1993, Proposed Plan. EPA is selecting the preferred alternative of the Proposed Plan, treatment by chemical neutralization/precipitation with HDS process option. EPA is not requiring use of sulfide based upon treatability study results from the design work for the Boulder Creek treatment plant. Peak AMD flows could be treated with a simple mix treatment plant, consistent with the process configuration selected for the Boulder Creek treatment plant.

The major components of the selected remedy include:

- Collection structures, pipelines, and equalization to provide for delivery of all AMD flows from the Old/No. 8 Mine Seep to the treatment facility for treatment.

- Additional or expanded treatment facilities to perform chemical neutralization/precipitation treatment of the Old/No. 8 Mine Seep AMD flows at the Minnesota Flats plant site. The treatment plant effluent shall meet the effluent limitations of 40 C.F.R. §§440.102(a) and 440.103(a). Except for pH and TSS levels for discharges into Boulder Creek, Slickrock Creek, or contaminated parts of Spring Creek, EPA has determined that these standards are relevant and appropriate in this application. If the discharge is made to one of these creeks, it will not be possible to adjust the pH due to the expected acidity in the creeks. Treatment for TSS levels would not be practicable due to the high levels of

TSS already in the creeks. If the discharge is made to Flat Creek, which is not expected to be acidic from other sources, the pH and TSS standards would be relevant and appropriate.

EPA has selected treatment Alternative O/N8-1, the HDS process option, as the required treatment technology option. The HDS process option, as discussed in the Boulder Creek OUFS, relies upon simple mix treatment and equalization for peak flows beyond the capacity of the HDS plant. The HDS plant shall be designed to provide capacity to treat sustained elevated flows from the Old/No. 8 Mine Seep. In conducting design studies for the plant, EPA has concluded that the HDS plant may be designed with a simple mix peaking plant.

- Disposal of treatment residuals onsite in the inactive open pit mine, Brick Flat Pit. Brick Flat Pit shall be modified to comply with the applicable requirements of the Toxic Pits Control Act, Health and Safety Code §25208, et seq., and California requirements for disposal of mining wastes promulgated under Water Code Section 13172.

The collection and conveyance systems shall provide for delivery of all base, sustained, and peak AMD discharges from the Richmond and Lawson adits. The treatment plant shall provide equalization capacity, treatment capacity, or a combination of both to ensure that all of the AMD flows are treated in compliance with the performance standards. The conveyance and treatment facility design shall provide for excess capacity and redundancy of elements necessary to assure reliability of performance.

The routing of pipelines and siting of tankage and treatment facilities is expected to have minimal impacts on the undisturbed habitat. The historic mining-related disturbance is significant, caused by collapse of the underground workings, surface mining, and establishment of roadways and cleared work areas. Pipeline routing and design and siting of facilities shall minimize impacts on undisturbed habitat by use of existing cleared work areas and roadways to the maximum extent practicable and by avoidance of siting of any facilities in areas of riparian or wetland habitat.

EPA has selected the HDS process option (O/N8-1) for the following reasons:

- The HDS process produces treatment sludges with superior characteristics with respect to dewatering and leachability. The smaller volumes of denser sludge are expected to significantly increase the life of Brick Flat Pit for use as an onsite sludge disposal facility. The superior leaching characteristics may allow for reduced regulatory requirements on the design of the modifications to Brick Flat Pit for sludge disposal.

- The sludge from an HDS plant could be placed in Brick Flat Pit dry. Although Brick Flat Pit modification designs must address several significant issues such as storm runoff, the design for placement of HDS sludges is significantly less complicated, and its operation is more within conventional engineering practice.

- EPA has chosen to site the treatment plant downgradient of the AMD discharges. The reliance upon HDS for treatment of base flows will reduce the annual O&M cost for hauling sludges to Brick Flat Pit for disposal by a significant amount. EPA has concluded that siting at a downgradient location could be more easily engineered to assure reliable operations. The use of the HDS process option may make this alternative site cost-effective by significantly reducing the volumes of sludge that must be trucked to Brick Flat Pit for disposal.

Use of the same treatment plant as the Boulder Creek OU will save additional construction and operation costs.

For the HDS process treatment facility located at the Minnesota Flats site, the treatment plant would discharge to lower Spring Creek and shall meet the requirements of 40 CFR §440.102(a) and §440.103(a), except pH and TSS standards. Because lower Spring Creek will not attain ambient water quality criteria pursuant to remedial actions being performed in the Old/No. 8 Mine Seep OU, EPA is invoking the ARARs waiver for "interim measures" provided by the NCP at 40 CFR 300.430(f)(1)(ii)(C)(1). EPA is not requiring that the discharge from the treatment plant meet the ambient water quality criteria in lower Spring Creek for this interim action.

For the HDS treatment facility located at Minnesota Flats, it is relevant and appropriate to provide protection of the Flat Creek drainage, including meeting the effluent limitation for pH and TSS at 40 CFR §440.102(a). Flat Creek does not currently meet all ambient water quality criteria (AWQC) and Basin Plan water quality standards due to a pollution source on Upper Spring Creek, the Stowell Mine. Once this source is remediated by RWQCB, EPA expects that Flat Creek could meet AWQC and water quality standards. Therefore, discharges from the dewatering of sludge that do not meet AWQC must be prevented from entering Flat Creek. Proper design of the dewatering ponds is an economically viable option, although mechanical dewatering can also be considered.

Brick Flat Pit must be modified to function as a safe, long-term disposal site for treatment plant sludges. The remedial design of the disposal facility in Brick Flat Pit shall address and comply with the requirements of the Toxic Pits Control Act and the California mining waste requirements. The discharge from Brick Flat Pit shall comply with California mining waste requirements. Because Boulder Creek and Slickrock Creek do not currently comply with ambient water quality criteria, and remediation of sources in the interim action pursuant to the Old/No. 8 Mine Seep OU will not allow for compliance with these standards without further actions, EPA is relying upon a waiver for "interim measures" and is not requiring that the discharge from Brick Flat Pit meet ambient water quality criteria in surface waters receiving the discharge.

Some modifications and refinements may be made to the remedy during remedial design and construction. Such modifications or refinements, in general, would reflect the results of the engineering design process. Estimated cost for the remedy is $10.4 million. Details of the costs for the treatment component are shown in Table 5, and capital costs and O&M costs are shown in Table 6.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action for the site comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted. The selected remedy must also be cost-effective and use permanent treatment technologies or resource recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy for the Old/No. 8 Mine Seep OU at the Iron Mountain Mine site meets these statutory requirements.

Table 5
Incremental Cost Summary for Alternative O/N8-1 ($ x 1,000)

Component	Incremental Cost
Site Preparation and Access Roads	56
AMD and Process Water Conveyance System	1,362
Treatment Plant (Including Equalization and Copper Cementation)	677
Brick Flat Pit Improvements	200
Construction Subtotal	2,295
Bid Contingencies (10 percent)	230
Scope Contingencies (30 percent)	689
neral Contingencies (8 percent)	184
Construction Total	3,398
Permitting and Legal (3 percent)	102
Services During Construction (10 percent)	340
Total Implementation Cost	3,840
Engineering Design Cost (15 percent of Construction Total)	510
Total Incremental Capital Cost	4,350
30-Year Present Worth of Incremental O&M Costs (Interest = 5 percent)	3,920
Total 30-Year Incremental Present Worth (Interest = 5 percent)	8,270

Table 6 Incremental Annual Operation and Maintenance Cost Summary for Alternative O/N8-1 ($ x 1,000)	
Component	**Incremental O&M Cost**
Access Roads	9
AMD and Process Water Conveyance	75
Treatment Plant (Including Equalization and Copper Cementation)	147
Sludge Disposal at Brick Flat Pit	24
Total Yearly Incremental O&M	255
Total Incremental Present Worth of 30-year O&M (Interest = 5 percent)	3,920

X.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment from the exposure pathways that are being addressed in this interim action. The selected remedy addresses the AMD discharges from the Old/No. 8 Mine Seep. The human health threat posed by this source is small and related to direct contact or ingestion of the AMD, which is unlikely due to the remote location, rugged topography, and restriction of access to the property. The environmental threats posed by this source are the very significant releases of copper, cadmium, zinc, and acidity into surface waters. The selected remedy will essentially eliminate the discharges from the source being addressed in this interim action. The Old/No. 8 Mine Seep is a very effective collector of the AMD that is believed to originate in the Old Mine and No. 8 Mine workings. Treatment of the discharges is expected to reduce the copper, cadmium, and zinc by greater than 99 percent.

The Old/No. 8 Mine Seep OU provides for an interim action that is not expected to be final and does not address all of the sources of discharges from the site. The selected remedy therefore cannot be expected to be fully protective of the environment in those areas affected by other discharges.

X.2 Compliance with ARARs

The selected remedy for the Old/No. 8 Mine Seep OU provides for an interim remedial action for a specific source at the site. The selected remedy provides for significant progress toward meeting the objectives of the Superfund cleanup action at Iron Mountain Mine by providing for significant reductions in the discharges of copper, cadmium, zinc, and acidity from the site. In particular, the remedy will result in better water quality in the Sacramento River and reduce the number of days each year that the Sacramento River exceeds State Basin Plan standards due to discharges of copper, cadmium and zinc from IMM. This section discusses the ARARs which the action shall meet and identifies the ARARs which are being waived.

The Old/No. 8 Mine Seep AMD discharge is similar in its nature and characteristics to the Richmond and Lawson portal AMD discharges which were addressed in the September 30, 1992, Record of Decision (ROD) for the Boulder Creek Operable Unit at IMM. The September 30, 1992, ROD thoroughly discusses the ARARs for this type of source, AMD containing high concentrations of copper, cadmium, and zinc, and also discusses the ARARs for the selected remedy, treatment with onsite sludge disposal or discharge of the treated effluent to lower Spring Creek. The September 30, 1992, ROD discussion regarding ARARs in Section X.2 is incorporated fully by reference. The discussion below summarizes the compliance of the selected remedy for the Old/No. 8 Mine Seep OU with ARARs.

X.2.1 AMD Discharge. The components of the selected remedy to address the Old/No. 8 Mine Seep AMD discharge are collection, treatment, and disposal of treatment residues onsite. This action shall comply with the following ARARs in the manner described:

X.2.1.1 Chemical-Specific ARARs. Chemical-specific ARARs for the selected treatment remedy include the Clean Water Act effluent limitations for discharges of mine drainage from copper mines, exercise of best professional judgment under the Clean Water Act, Safe Drinking Water Act Maximum Contaminant Levels (MCLs), and non-zero Maximum Contaminant Level Goals (MCLGs) at the water intake to the City of Redding, and the Basin Plan water quality objectives.

The primary adverse environmental impact from the IMM discharges is the impact on surface waters and the species which live in those waters. CERCLA provisions respecting water quality criteria and the requirements of the Clean Water Act and California Water Code are ARARs for the Site.

In the final remedy, any discharge from the mine to surface waters should comply with the water quality objectives in the Central Valley Regional Water Quality Control Board's Basin Plan. In determining the manner in which the mine discharges should be controlled to achieve these levels, EPA may use best professional judgment (BPJ) to determine the level of control. In addition to the use of BPJ to achieve the water quality objectives in the receiving waters, EPA considers effluent limitations on related mining activities as relevant and appropriate.

The selected treatment remedy for the Old/No. 8 Mine Seep OU will comply with the following chemical-specific ARARs:

- Substantive requirements of NPDES permitting or substantive requirements regarding Waste Discharge Requirements

- Use of BPJ to establish effluent limitations where there is no regulation of the specific discharge

- The BPT and best available technology (BAT) limits for point sources at copper and zinc mines (40 CFR §§440.102(a) and 440.103(a) (for treatment plant discharges to lower Spring Creek, EPA has determined that the limits for pH and TSS are not "relevant and appropriate")

- MCLs and non-zero MCLGs established under the Safe Drinking Water Act for the Sacramento River near Redding's Jewel Creek intake

The selected treatment remedy for the Old/No. 8 Mine Seep is an interim remedy and does not address all of the sources of contamination at the site. Treatment of the Old/No. 8 Mine Seep AMD discharge, in combination with other remedies already selected for the site, cannot assure compliance with all ARARs. Further actions will be required. The selected remedy will comply with all ARARs to the extent practicable in the context of the interim remedial action. However, EPA expects that it is necessary to waive the following ARARs for the interim remedial action:

- The water quality objectives of California's Central Valley Basin Plan for the Sacramento River and its tributaries above the State Highway 32 bridge

- Water quality objectives of the California Inland Surface Waters Plan

X.2.1.2 Action-Specific ARARs. The selected remedy shall address and comply with all action-specific ARARs. Significant action-specific ARARs include those relating to disposal of the treatment sludge and ARARs directing activity to protect affected fisheries and habitat.

Selection of this alternative is consistent with statutes such as the Federal and California Endangered Species Act and the Fish and Wildlife Coordination Acts because the remedial alternative is being developed pursuant to a process of consultation like that required by the Acts. The alternative would also comply with Fish and Game Code Section 1505, since the improved water quality should result in greater protection of fishery habitat in the Sacramento River below Keswick Dam.

The disposal unit used for the treatment residue should comply with the applicable provisions of California Water Code Section 13172 and Health and Safety Code Section 25208, et seq. (Toxic Pits Control Act, or TPCA). The Regional Board mining waste requirements are ARARs which are applicable to the disposal of the treatment residue. It is expected that chemical analysis of the treatment residues from the HDS plant will indicate that the wastes are properly categorized as Group B wastes.

Although the HDS sludge will be less aqueous than the simple mix sludge, it may still contain free liquids subject to TPCA provisions.

Consequently, the unit must not be located in a Holocene fault; shall be located outside areas of rapid geologic change; shall require flood-plain protection from a 100-year peak streamflow; shall have liners and a filtrate collection system; shall have precipitation and drainage controls for a 10-year, 24-hour storm; and shall comply with specific monitoring requirements.

Insofar as the sludge contains free liquids, the disposal unit must also comply with TPCA, which prohibits discharge of free liquids into a surface impoundment unless the surface impoundment does not pollute or threaten to pollute the waters of the State. If the treatment sludge contains free liquids, the design of the disposal unit must be such that the unit does not pose a threat to pollute the waters of the State.

X.2.1.3 Location-Specific ARARs. The selected remedy shall address and is expected to comply with all location-specific ARARs. EPA has determined that the RCRA requirements for management of hazardous wastes, including siting and construction criteria, are not relevant and appropriate to the management and disposal of residuals from treatment of the AMD discharges or the waste piles. EPA is employing a variance from Hazardous Waste Control Law requirements for disposal of the non-RCRA waste. Accordingly, the selected remedy shall comply with requirements of the Toxic Pits Control Act and California requirements for management and disposal of mining wastes, including siting and technology requirements for disposal facilities.

The action shall comply with the following location-specific ARARs:

- Archeological and Historic Preservation Act
- National Historic Preservation Act
- Clean Water Act (Section 404)
- Executive Order on Floodplain Management
- Executive Order on Protection of Wetlands

X.2.2 ARAR Waivers For this Operable Unit. This section summarizes which ARARs are subject to ARAR waivers. Because the Old/No. 8 Mine Seep Operable Unit is an interim remedy, it can qualify for the ARAR waiver for such actions. CERCLA §121(d)(4)(A), 42 U.S.C. §9621(d)(4)(A), provides that ARARs may be waived if "the remedial action selected is only part of a total remedial action that will attain such level or standards of control when completed."

The ARARs which are being waived for purposes of this operable unit are:

- The Basin Plan water quality objectives, discussed in detail below. Because the treatment plant does not address all sources that are contributing to the exceedances of the water quality objectives, it is not pos sible to fully comply with ARARs until further response actions are selected and implemented.

- Fish and Game Code Section 5650, which prohibits "permit[ting] to pass into...the waters of this State...substance or material deleterious to fish, plant life, or bird life." Because the treatment plant would not address all sources at this site, this alternative would not eliminate all releases. It would, however, eliminate 99 percent of the material passing into the waters from the two portal sources.

The overall remedy, including the activities in the 1986 Record of Decision, the 1992 Boulder Creek Record of Decision, this Operable Unit, and subsequent operable units are expected to achieve compliance with these ARARs (at least in those portions of the site immediately below Keswick Dam).

EPA has previously stated that the Old/No. 8 Mine Seep Operable Unit will be followed by other studies and remedial actions to address matters such as releases from Slickrock Creek nonpoint sources and the sediments in the Spring Creek arm of Keswick Reservoir. Those activities are not a part of this OU. The Old/No. 8 Mine Seep Operable Unit, however, is not expected to achieve this ARAR in all years without the planned further remedial action. As such, it is an interim remedy. In the event of an interim remedy, EPA may elect to invoke an interim remedial action waiver as provided in CERCLA §121(d)(4)(A), 42 U.S.C. §9621(d)(4)(A).

There is also some question regarding the technical practicability of meeting water quality objectives in certain segments of Boulder, Slickrock, and Spring Creeks. In particular, it may not be technically practicable to meet the water quality objectives in certain portions of these creeks. In such a case, EPA may consider the use of a waiver under CERCLA §121(d)(4)(C), 42 U.S.C. §9621(d)(4)(C). The preamble to the NCP discusses the use of the technical impracticability waiver at 55 Fed. Reg. 8748 (March 8, 1990). The main criteria for invoking this ARAR waiver are engineering feasibility and reliability. EPA explained in the preamble that cost plays a "subordinate role" in determining whether a remedial action is "practicable from an engineering perspective." Id. Because this action is an interim remedial action, EPA is not today reaching any conclusions regarding the technical impracticability of achieving ARAR compliance in Boulder, Slickrock, and Spring Creeks, but is invoking the interim remedy waiver for all stream segments.

The selected remedy will not provide for compliance with the applicable chemical-specific ARARs of the Central Valley Regional Water Quality Control Basin Plan water quality objectives, as discussed above. The selected remedy will allow for compliance with these water quality objectives most of the time and represents a significant improvement compared to the no-action alternative, O/N8-0. The selected remedy will not provide for meeting water quality objectives in Slickrock Creek.

Subsequent remedial measures will address other sources of contamination that prevent achievement of the water quality objectives in the Sacramento River. A subsequent study will also address whether or not a waiver for technological impracticability is appropriate for water quality objectives in the creeks adjacent to Iron Mountain Mine.

X.3 Cost-Effectiveness

EPA has concluded that the selected remedy is cost-effective in mitigating the risk posed by the discharge of heavy-metal-laden AMD from the Old/No. 8 Mine Seep to surface waters. Section 300.430(f)(ii)(D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for effectiveness in proportion to its cost. The estimated cost for the selected HDS treatment remedy is $8.3 million.

X.4 Utilization of Permanent Solutions and Alternative Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be employed in a cost-effective manner for the interim remedial action for the Old/No. 8 Mine Seep OU at Iron Mountain Mine.

EPA recognizes that the mineralization at Iron Mountain Mine will continue to generate AMD unless additional remedial actions are developed, evaluated, and selected for implementation to reduce or eliminate the AMD-forming reactions. Treatment does not address the reactions themselves. Treatment effectively addresses the resultant discharges. EPA has developed and evaluated alternatives as part of the ongoing remedial investigation and feasibility study activities at IMM that could reduce or eliminate the AMD-forming reactions. Resource recovery alternatives have also been proposed and evaluated. EPA has concluded that further information is required to be developed and evaluated before one of these approaches could be selected for implementation. The needed further information would address technical feasibility, implementability, effectiveness, and cost-effectiveness concerns and risk factors with respect to these approaches. EPA encourages the further development of alternatives that could control the AMD-forming reactions and resource recovery alternatives for future evaluation and potential selection in a subsequent action.

The selected remedy will provide for a significant reduction in the copper, cadmium, zinc, and acidity discharges from the site. The current water supply and fishery conditions are critical. There is a critical need to implement controls on these discharges as soon as possible, while studies are ongoing with respect to further source control or resource recovery approaches. Treatment is effective, a part of each approach developed to date, and is consistent with implementation of a subsequent action.

X.4.1 Preference for Treatment as a Principal Element. Although EPA is not selecting a remedy which treats the source such that no further AMD is formed, EPA is using treatment to reduce the toxicity and mobility of the AMD which is being generated. By selecting the HDS treatment process instead of the simple mix treatment process, the AMD treatment will also reduce the expected volume of the sludge. HDS sludge will also be less toxic than the simple mix sludge.

Mine sealing or plugging alternatives present the potential to completely stop the AMD-forming reactions and the discharge if the surrounding rock mass can contain a mine pool at elevations sufficient to inundate all mineralization. The plugging alternatives might (with innovative approaches) address acidic metal-laden salts that dissolve in the flooding mine pool and thus are mobilized and create a discharge pathway through fractures or mining-related openings. A partially successful plugging alternative would reduce the AMD-forming reactions, but not eliminate them. A partially successful program presents risks of release of contaminants to the environment.

Other alternatives such as intercepting groundwater flow and capping areas which channel infiltrating water toward mineralization would likely reduce the rate of reaction of the AMD formation, but not eliminate them. These alternatives provide less risk of creating new discharge pathways and rely on conventional engineering approaches.

Resource recovery approaches merely treat the discharge, recovering economic values. Conventional treatment is effective at eliminating the discharge, but does not treat the sources of the discharge.

EPA encourages the continued development and evaluation of alternatives that may partially satisfy the preference for treatment as a principal element, and this issue will be addressed in the final decision document for the site. EPA has concluded that further development and evaluation of the above approaches is necessary to address uncertainties with respect to technical feasibility, implementability, effectiveness, cost-effectiveness concerns, and risk factors.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

EPA is today approving the Proposed Plan. There are no significant changes.

EPA will locate the Old/No. 8 Mine Seep treatment plant at Minnesota Flat. As EPA proposed in its February 11, 1993, Proposed Plan for the Old/No. 8 Mine Seep OU, EPA will co-locate the Old/No. 8 Mine Seep treatment plant with the Boulder Creek treatment plant to take advantage of cost savings that can be realized from this approach. EPA has selected Minnesota Flat for the plant site based upon cost and reliability considerations developed and evaluated in detail during design of the Boulder Creek treatment plant. In conducting treatability studies for the plant, EPA has concluded that it is not necessary to require that sulfide be used in the treatment process. Treatability studies have shown that the addition of sulfide hinders the formation of the HDS sludges. Since the same plant and process will be used for the discharges from this OU, sulfide will not be required for treatment.

STATE OF CALIFORNIA — ENVIRONMENTAL PROTECTION AGENCY PETE WILSON, *Governor*

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
REGION 1
10151 CROYDON WAY, SUITE 3
SACRAMENTO, CA 95827-2106
(916) 255-3545

September 9, 1993

Mr. Dave Jones
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

IRON MOUNTAIN MINE; AGENCY REVIEW DRAFT, OLD/NUMBER 8 MINE RECORD OF DECISION

Dear Mr. Jones:

We have received the agency review draft of the Old/Number 8 operable unit Record of Decision (ROD) for the Iron Mountain Mine Superfund Project. We concur with the U. S. Environmental Protection Agency's (EPA) interim remedy selection of treatment for the acid mine drainage flows emanating from the Old/Number 8 Mine Seep. We agree that Minnesota Flats appears to be a suitable location for the treatment plant and that Brick Flat Pit, after modification to comply with the Toxic Pits Control Act, California Water Code, Section 13172 and the regulations adopted thereunder, appears to be a suitable location for permanent disposal of sludges.

At this point in time, however, we are unable to concur with the selection of the high density sludge (HDS) treatment method. In principle, we agree that HDS is a preferable treatment methodology due to its reputably superior sludge characteristics. Those characteristics, when compared to the sludge generated by the simple mix process, include higher solids content (lower resultant sludge volume), superior handling and disposal characteristics and superior dewatering/leachate characteristics. But in light of Stauffer Management Company's (SMC) representations and plans with regard to the construction of a 300 gallon per minute aerated simple mix plant (which doubles as a 1400 gallon per minute partially aerated simple mix plant), we have insufficient information upon which to base a conclusion that HDS is necessary.

We envision the following actions at the site:

1. SMC should construct the plant as required by EPA Order 93-1 (as proposed to be amended in EPA's July 15, 1993 letter to SMC and SMC's July 27, 1993 letter to EPA) and the State's Order I/&SE 93/94 002 (as proposed to be amended in our August 10, 1993 letter to SMC).

2. Facilities to convey the Old/Number 8 Mine Seep Acid Mine Drainage flows to the treatment plant be constructed in the summer of 1994 as required by the State's Order I/&SE 93/94 002.

3. Performance of the treatment plant will be monitored in accordance with an approved monitoring plan during the rainy season of 1994/1995. Optimal operational parameters will be determined during this time frame.

4. If conditions warrant, i.e., the quantities and quality of the sludge generated by the SMC plant prove to be unmanageable, the HDS plant is then constructed.

If you have any questions or concerns, please call me or Mr. Duncan Austin at (916) 255-3706.

Sincerely,

Anthony J. Landis

Anthony J. Landis, P.E., Chief
Site Mitigation Branch

cc: Mr. James Pedri
Regional Water Quality Control Board
415 Knollcrest Drive
Redding, California 96002

Mr. Harry Rectenwald
California Department of Fish and Game
601 Locust Street
Redding, California 96001

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

IN REPLY REFER TO:

August 31, 1993

Mr. Rick Sugarek
Region IX
Environmental Protection Agency H-6-2
75 Hawthorne St.
San Francisco, CA 94105

Dear Mr. Sugarek:

Thank you for the opportunity to review the Record of Decision presenting interim remedial actions for discharges from the Old/No. 8 Mines. While we agree with the selection of treatment technology as the interim remedy, we are concerned that by concentrating on the single seep, other discharge points are escaping capture by the system. Each such discharge in Slickrock Creek that escapes capture and treatment is eventually collected at Spring Creek Debris Dam and increases the need for dilution water.

We suggest that if such a remedy is selected, that it include efforts to collect more of the discharge. Alternatives include placement of the treatment facility downstream or collection at the seep site itself (in much the same way as a spring would be developed).

Sincerely,

Patricia Sanderson Port
Regional Environmental Officer

cc:
Kris Doebbler, BR
Roger Helm, FWS
Denise Klimas, NOAA
Harry Rectinwald, CA Fish and Game

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean Resources Conservation and Assessment
Hazardous Materials Response and Assessment Division
Coastal Resources Coordination Branch

September 7, 1993

Mr. Rick Sugarek (H-6-2)
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105

Subject: Review of the Iron Mountain Mine Old/No. 8 Mine Operable Unit Draft Record of Decision.

Dear Mr. Sugarek:

The Natural Resources Trustee Council for the Iron Mountain Mine Superfund site, comprised of the National Oceanic and Atmospheric Administration, the National Marine Fisheries Service, the Department of Interior Office of Environmental Affairs, the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, and the California Department of Fish and Game, has reviewed the August 6, 1993 Agency Review Draft Record of Decision (ROD) for the Old/No. 8 Seep at Iron Mountain Mine (IMM). The Natural Resources Trustees previously commented on the agency review draft of the Remedial Investigation/Feasibility Study for the Operable Unit. The alternative selected in the ROD is consistent with the treatment alternative recommended by the Natural Resource Trustee Council in the April 8, 1993 letter. However, we believe that the details on the **amount** of contamination that is collected for treatment is not consistent with our earlier recommendation. We also have some comments on the details of implementing the selected alternative and some comments on technical discussions contained in the document.

The Operable Unit is defined as the Old and No. 8 Mines. We believe that because these mines are buried by tens of feet of loosely consolidated landslide material, there is more contamination coming from the mines than is accounted for by the most obvious seep that is the focus of the remedial action. The ROD should disclose how the releases from this buried, leaking, flooded ore body travel through several known or potential migration routes to surface waters. The amount of contamination from the source (Old/No. 8 Mine Operable Unit) that will be treated by remedial action will depend upon the efficiency of the collection system for the discharge from the buried mines. We recommend developing the most effective design possible for collecting acid mine discharge (AMD) from the buried and flooded mine workings.

We believe that maximizing the collection of the contaminants from this flooded mine pool (Operable Unit) is consistent with the National Contingency Plan (NCP). Reducing the contamination better satisfies the evaluation criteria, including protection of the environment, long- and short-term effectiveness, and compliance with Applicable or Relevant and Appropriate Requirements.

Specific Comments:

Page 2, 2nd Paragraph, 1st Sentence: The subject seeps are emerging from the **north** slope of Slickrock Valley or the **south** facing slope of Iron Mountain.

Page 2, 3rd Paragraph: The ROD correctly describes the Sacramento River winter-run chinook salmon as listed Threatened by the National Marine Fisheries Service under the Federal Endangered Species Act; you should include also that the species has been listed as Endangered by the State of California, under the California Endangered Species Act.

Page 2, Paragraph 5, Second Sentence: The diversion of upper Spring Creek is into Flat Creek and is not in the Boulder Creek drainage.

Page 18, 2nd Paragraph: This discussion should disclose that contamination from the Old/No. 8 Mine workings Operable Unit has many known and potential migration routes to the surface waters in the Slickrock Creek drainage. We believe this is the case, considering the fact that the releases from this mine pool must first flow through several tens of feet of loosely consolidated landslide material before reaching the surface. After AMD from the flooded mine pool emerges through the buried mine portal, it can diffuse throughout the landslide formation. There is evidence that seeps down-gradient from the main identified seep have a chemical characteristic and flow pattern similar to the main seep, indicating a common source (Old/No. 8 Mine Operable Unit).

We believe that the selected remedy for this Operable Unit should be designed to abate as much of the contamination originating from this source that is possible. It appears that the site would lend itself to designs that would pass the implementability evaluation criteria in the NCP. It would be most prudent to establish collection systems at an elevation at least as deep as the buried mine portals.

Page 19, 1st Paragraph, 2nd Sentence: The fish toxicity should be described as <u>acute</u> toxicity, rather than just toxicity, because chronic toxicity levels are much lower than the values specified here. Acute toxicity also occurs at concentrations lower than those specified in this discussion, especially if the concentrations referred to are in the form of dissolved metals.

Page 21, 4th Paragraph, 3rd Sentence: Fishery data in this discussion is outdated. During and prior to the recent, extended drought, the salmon and steelhead were undergoing a decline that at that time produced a population that was only 50 percent the size of the earlier populations. The drought greatly accelerated this ongoing decline, producing escapements of salmon in the upper Sacramento River during the 1990's that are now only 20 percent of the levels observed during the late 1950's.

Page 22, 1st Paragraph, 3rd Sentence: The flood control releases from Shasta Reservoir described here should be qualified as **high volume** flood control releases. This qualification will avoid confusion with other flood control operations at Shasta Dam that produce a very low volume release to prevent compounding ongoing flooding of downstream areas in the Central Valley. This low volume release operation has produced catastrophic fish kills in the past, because it does not encourage downstream migration and reduces dilution of toxicant.

Page 22, 2nd Paragraph, 1st Sentence: Spring-run chinook and early spawning fall-run chinook have also exhibited this pattern of concentrating spawning activity in the cooler uppermost river reaches that are more susceptible to metal toxicity.

Page 22, 3rd Paragraph: The risk to resident trout and steelhead is overall less than that for salmon due to the fact that the sensitive early life stages of trout and steelhead are predominantly located in tributaries to the Sacramento River that do not receive the toxicant.

Page 31, 1st Paragraph, 1st Sentence: The concept for collection of AMD at the Old/No. 8 Seep is intended to provide both surface and underground interception of the flows. We believe it is important to collect the AMD emanating from these ore bodies to the **maximum extent possible,** in order to comply with the nine evaluation criteria specified by the National

Contingency Plan (40 CFR §300.430 (e)(9)). See also above comment concerning Page 18, 2nd Paragraph.

Page 52, 1st Paragraph, last sentence: The Natural Resource Trustees have previously commented on the failure of a mine plugging program similar to that described in this section. One of the greatest risks to biological resources in general, and the ESA listed winter-run chinook salmon in particular, is the likelihood that contaminants from the leaking mine pool would be released in a manner that would be uncollectible or only fractionally collectable for treatment. This, in our opinion, represents a severe risk. This risk should be included in this discussion.

If you have any questions regarding these comments, please contact one of the following:

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2) Ms. Denise Klimas, National Oceanic and Atmospheric Administration, San Francisco CA (415) 744-3126

3) Mr. Roger Wolcott, National Marine Fisheries Service, Santa Rosa, CA (707) 578-7513

4) Mr. Jim Haas, U.S. Fish and Wildlife Service, Sacramento, CA (916) 978-4866

5) Ms. Kris Doebbler, U.S. Bureau of Reclamation, Sacramento, CA (916) 978-5046

6) Mr. Richard Elliott, Regional Manager, California Department of Fish and Game, Redding, CA (916) 225-2364

Sincerely,

DEPARTMENT OF THE INTERIOR

BY: [signature]

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